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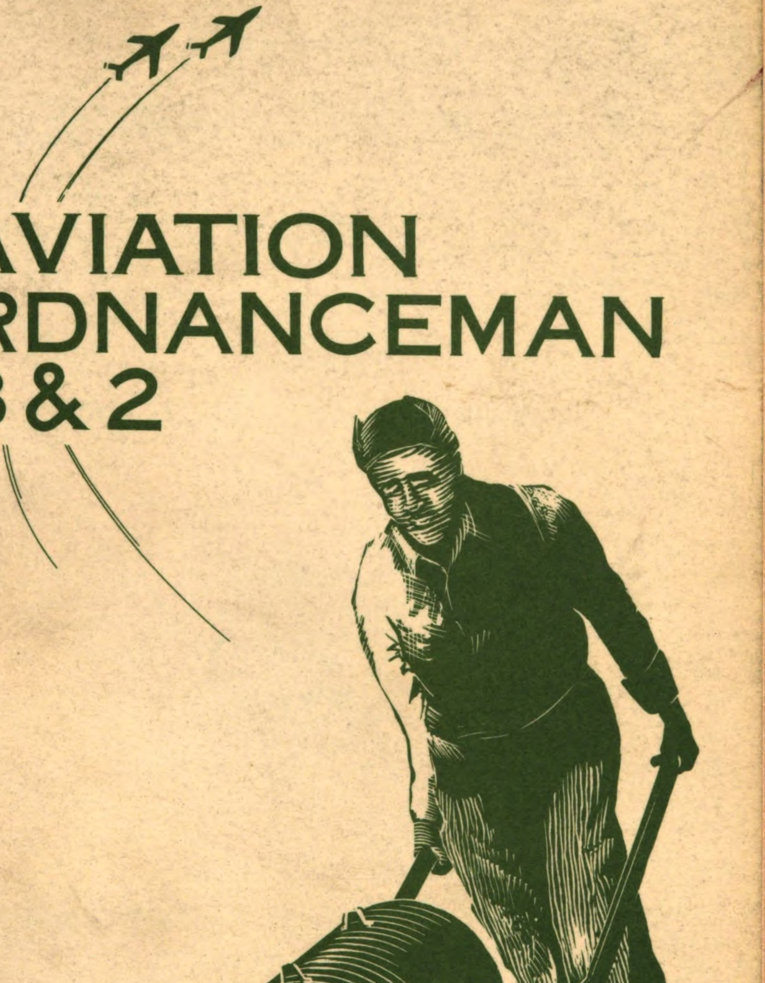
AVIATION ORDNANCEMAN 3&2



VOL. 1

NAVY TRAINING COURSES

AVIATION ORDNANCEMAN 3 & 2

Volume 1

Prepared by

BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSES

NavPers 10345

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1955

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PREFACE

This book is one of a series of NAVY TRAINING COURSES written especially for Aviation Ordnancemen. In conjunction with *Aviation Ordnanceman 3 and 2*, Volume 2, it is based on the qualifications for the rates of Aviation Ordnanceman, Third Class, and Aviation Ordnanceman, Second Class, as stated in the *Manual of Qualifications for Advancement in Rating*, NavPers 18068 (Revised). These qualifications may be found in appendix II of this book.

The first chapter provides general information concerning aviation ordnance, including sections on publications and ordnance supply. Subsequent chapters take up explosives; munitions, including bombs, mines, rockets, and pyrotechnics; and gun ammunition. In conclusion, there is a chapter on aviation munitions handling equipment.

Volume 2 begins with a chapter on small arms, followed by the caliber .50 machine gun, and a chapter on 20-mm guns. Also included are chapters on turrets, tow target equipment, release equipment, and gun cameras.

As one of the NAVY TRAINING COURSES, this book was prepared jointly by the U. S. Navy Training Publications Center, Memphis, Tenn., and the Training Division of the Bureau of Naval Personnel.

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Aircraft Munitions, NavPers 10343
Aircraft Turrets, NavPers 10344–A
Aviation Supply, NavPers 10394–C
Blueprint Reading, NavPers 10077
Basic Hand Tool Skills, NavPers 10085
Electricity, NavPers 10622–B
Aircraft Hydraulics, NavPers 10332–A

USAFI TEXTS

United States Armed Forces Institute (USAFI) courses for additional reading and study are available through your Information and Education Officer.* A partial list of those courses applicable to your rate follows:

Number	**Title**
	Correspondence
CA 781	*Fundamentals of Electricity*
CA 835	*Machine Shop I*
CB 290	*Physics I*
CB 275	*General Science*
	Self-Teaching
MA 781	*Fundamentals of Electricity*
MA 835	*Machine Shop I*
MB 290	*Physics I*
MB 275	*General Science*

*"Members of the United States Armed Forces Reserve components, when on active duty, are eligible to enroll for USAFI courses, services, and materials if the orders calling them to active duty specify a period of 120 days or more or if they have been on active duty for a period of 120 days or more, regardless of the time specified in the active duty orders."

STUDY GUIDE

Strikers for the AO and AOU rating will be required to read all chapters of this book. Strikers for the AOT rating may omit chapter 4 since it contains materials not included in their required qualifications.

AVIATION ORDNANCEMAN 3 & 2

Volume 1

CHAPTER 1

INTRODUCTION TO AVIATION ORDNANCE

Many men engaged in a great number of specialized fields are needed to maintain the Navy's air arm in a condition of constant military readiness. All these specialists are mutually dependent, and each contributes his part to the efficient operation of the entire organization.

The Aviation Ordnanceman plays a major role as a member of this organization. A good Aviation Ordnanceman is an expert on ordnance and armament equipment used by naval aircraft.

Aviation ordnance and armament equipment includes all the offensive and defensive weapons and munitions used on aircraft. This also includes such equipment as fire control and sighting systems, together with auxiliary devices for handling, maintaining, carrying, and firing (or releasing) airborne munitions from naval aircraft.

Airborne munitions encompasses all items of explosive ordnance and fuzes; included are machine gun ammunition, rockets, torpedoes, aircraft mines, guided missiles carried on aircraft, and other types of missiles which may be released by aircraft equipment.

Auxiliary equipment includes pyrotechnic and smoke-tank equipment, together with training and target materials for gunnery, bombing, and other combat activities. Also included are the maintenance items used with the above material, and equipment for handling and loading ordnance at shore bases, on carriers, and in aircraft.

Airborne ordnance and armament equipment are the materials which convert aircraft from work vehicles into combat weapons. The items come in wide variety, keeping pace with the expanding uses and capabilities of naval aircraft. They are constantly changing. As an Aviation Ordnanceman, you will have to keep up-to-date on these changes by studying the latest ordnance publications and by closely observing the work of experienced and competent ordnancemen.

Aviation Ordnancemen are experts on guns ranging from the smallest caliber training pistols to the 20-mm aircraft gun. You will work with guns, sights, bomb directors, fire control equipment, launchers and releasing equipment, and understand the technique of boresighting. Ordnancemen are trained to keep aircraft munitions ready for action at a moment's notice.

Aviation Ordnancemen take bombs from magazines, fuze them, and load them on aircraft. An aircraft is a flying platform for guns, bombs, rockets, and anything else you desire to shoot or drop from it. It is of no value unless the weapons work when needed. Pilots and aircrewmen risk their lives getting into the right spot to drop bombs or fire their guns. If assigned to a patrol squadron, you may be one of the aircrewmen serving as a gunner and general troubleshooter for the armament equipment.

Aviation Ordnancemen make sure that planes are loaded properly, that the ordnance gear operates properly, and that every naval aircraft is loaded with destruction whenever a plane takes off for a raid. With the skill of technicians, ordnancemen perform the duties that make aviation ordnance pay off.

ORDNANCE ORGANIZATION

The specific duties of Aviation Ordnancemen depend to a great extent upon the type of organization to which they are attached. As an Aviation Ordnanceman you may be attached to an operating squadron, a service squadron, the ordnance division of an air station, or the ordnance unit of an aircraft carrier or seaplane tender.

Squadron

The aircraft squadron is the standard operating unit in naval aviation. A squadron is composed of a number of assigned aircraft (the total number depending on the mission of the squadron) together with the necessary personnel for their operation, maintenance, and minor repairs.

A group of squadrons, comprising both fighter and attack, intended to operate as a unit aboard a carrier, is known as a Carrier Air Group (CAG). A group of patrol squadrons under one tactical commander is known as a Fleet Air Wing (FAW).

The senior naval aviator of a squadron is the Commanding Officer, being followed in rank by the Executive Officer. The squadron is usually organized into the following departments:

Administration
Operations
Maintenance
Material
Gunnery (or Ordnance)

Since the Aviation Ordnanceman is concerned primarily with duty in the gunnery or ordnance department, some of the major duties of the gunnery or ordnance officer are listed here:

Preparation of required reports.

Preparation and supervision of squadron rearming bill.

Supervision of gunnery training.

Promulgation of safety precautions.

Proper stowage, maintenance, distribution and accountability of ordnance material and classified matter in his custody.

Procurement of necessary items of ordnance material, equipment, and ammunition.

Supervision of instructing personnel in chemical warfare.

The ordnance officer is assisted in these duties by one or more assistants.

The squadron ordnancemen are responsible, under the leading Chief Ordnanceman, for the loading and unloading of all munitions, routine maintenance and minor repair of all squadron ordnance and armament equipment, and such other duties as may be assigned by the ordnance or gunnery officer. In most patrol squadrons each flight crew will include one or two ordnancemen who serve as gunners and troubleshooters for the ordnance and armament equipment on their plane.

FASRon

A FASRon (Fleet Aircraft Service Squadron) is a shore-based commissioned unit designed to support a group of fleet squadrons. The FASRon acts as a coordinating agency between the shore facility and the fleet aircraft units in all logistic requirements except berthing and messing.

FASRons are of two types, carrier and patrol. They are numbered as follows: 1–100, carrier; and 101–200, patrol type. A FASRon is usually organized into departments as follows:

Administration
Operations
Maintenance
Supply
Medical–Dental

FASRon ordnance is a division of the maintenance department. Listed below are the duties of the FASRon ordnance officer:

Supervision of all work under FASRon cognizance in the maintenance of ordnance equipment.

Supervision of the incorporation of ordnance changes, modifications, and inspections in accordance with current technical instructions.

Maintenance of adequate records to aid in preparing reports and provide information required by the maintenance officer.

Inspection and maintenance of ready magazines and their assignment to supported units. Posting, and insuring compliance with, pertinent safety precautions for the stowage and handling of ammunition and pyrotechnics in ready magazines.

Coordination of squadron ammunition requisitioning and liaison between supported aviation units and the shore activity in the procurement of munitions, including the return of unexpended munitions to designated stowage.

Maintenance and supervision of shops required for the work for which he is responsible.

FASRon ordnancemen generally are not required to do the routine maintenance and rearming, which are the duties of the supported squadrons' ordnancemen. However, the incorporation of all ordnance changes and modifications to squadron aircraft are among the responsibilities of FASRon ordnancemen. In addition, they perform all ordnance work requiring shop tools and services beyond the capabilities of the Fleet aircraft squadrons. The FASRon ordnance division usually includes rated minemen and special weapons personnel and the facilities for testing and maintaining these weapons.

Naval Air Station

The ordnance division of a naval air station is part of the station's operations department and its aviation ordnance activities are usually extensive and varied. Listed below are the usual aviation ordnance responsibilities:

Magazine area.
Ammunition and ready-service stowages.
Torpedo overhaul shop.
Small arms firing ranges.
Armory (with training and security weapons).
Ordnance training facilities.

In addition, if the station is a carrier port facility, ammunition loading from the air station magazines may also be an aviation ordnance function.

Many air stations have an Overhaul and Repair Shop. These shops have aviation ordnance and armament repair sections where Aviation Ordnancemen perform overhaul and major repair work on all types of aviation ordnance equipment.

Aircraft Carriers and Seaplane Tenders

Aircraft carriers and seaplane tenders are organized into the following departments:

Operations
Navigation
Gunnery (or Deck)
Engineering
Supply
Medical
Dental
Air

The air department is divided into divisions, one of which is the aircraft maintenance divison. Aboard the typical carrier or tender, the aviation ordnance unit is part of the aircraft maintenance division, although aboard some ships aviation ordnance is a separate division.

The aviation ordnance unit, or division, aboard a carrier has a wartime complement of two or more officers and 60 or more ordnance rates and strikers (depending on the size of the carrier). The material with which these men work may come from any one or more of some 40 compartments and spaces on many decks. Some of these ordnance locations are listed below:

Armories.
Ready-service machine gun ammunition magazines.
Ready-service fuze lockers.
Machine gun cleaning rooms.
Aircraft torpedo workshop and stowage.
Torpedo, bomb, and ammunition handling equipment stowage.
Bomb elevators.
Stowage for inert ordnance components.

Aboard carriers and tenders, the magazines for aircraft munitions are also the responsibility of the ship's Aviation Ordnancemen, under the cognizance of the ship's gunnery officer.

Generally, the aviation ordnance unit or division afloat provides the same services to embarked squadrons as does the

FASRon ashore. This includes breaking out, assembling, and delivering munitions to the squadron ordnancemen on the hangar or flight decks (or into rearming boats of tenders); incorporating required changes and modifications to squadron ordnance and armament equipment; and performing work involving shop tools and services. In addition, machine gun ammunition is belted as required and assigned equipment and spaces are maintained.

General Organization

In all the units listed above—squadron, FASRon, station, and ship—the ordnance division or unit will be headed by an officer, usually an aviation ordnance specialist (except in streamlined squadrons). This officer generally has one or more assistants, the number varying with the size of the unit. In charge of the enlisted ordnance complement is the leading Chief Aviation Ordnanceman. Organization varies widely, according to the type of duties performed. There may be rearming crews, armory crews for maintenance work, munitions-assembly details, and the like. There will almost always be a rated ordnanceman in charge of each crew, who is responsible to the leading chief for his crew and its work.

In small units with only a few men, there may be no such crews; in this case the leading chief assigns daily work details individually instead of by crews.

SAFETY PRECAUTIONS

Regardless of the type of organization to which you may be assigned, or the type of work which you may perform, safety precautions are of major importance in aviation ordnance.

The Bureau of Ordnance exercises general supervision over the safety of ordnance material and equipment and prescribes general and certain special regulations to be applied in all ordnance work. These regulations are set forth in the *Bureau of Ordnance Manual* and various other BuOrd publications which are discussed later in this chapter.

It must be borne in mind in studying and carrying out safety precautions that in the main they are derived from costly experience, and that the most serious casualties on record have resulted from negligence or violation of safety regulations then in effect. As an Aviation Ordnanceman striker or petty officer you must understand and comply with every safety precaution relating to the equipment and material with which you work. No relaxation of vigilance with respect to carrying out these regulations and instructions is ever permitted.

In the various chapters of this book you will find listings of safety precautions relating to specific types of munitions and equipment. These safety precautions have been taken from the *Bureau of Ordnance Manual* and other BuOrd publications, but are not to be considered as complete, and are subject to change by proper authority. Keep up-to-date on your safety regulations; make safety a habit, and you will enjoy a long and successful career as an Aviation Ordnanceman.

ADMINISTRATION

Cognizance of aviation ordnance and armament equipment is divided between the Bureau of Ordnance (BuOrd) and the Bureau of Aeronautics (BuAer). The respective Bureaus procure and pay for all items under their respective cognizance. In practice, the materials under the cognizance of BuOrd are called aviation ORDNANCE equipment; those under BuAer, aviation ARMAMENT equipment.

The Bureau of Ordnance has cognizance over aircraft guns, including those accessories which are built into the guns or which directly and continuously affect their operation or safety. This includes gun mounts and adapters, feed mechanisms, electric trigger controls, and auxiliary devices such as link loading and belting machines.

Other important classes of material and equipment under BuOrd are:

Aircraft sights, sighting systems, and fire control systems.

Munitions and fuzes for aircraft use, including machine gun and bomb-type munitions; torpedoes; mines; pyrotechnic and chemical munitions: rockets and rocket-type ammunition; small arms and ammunition used on carriers and at advanced bases.

Guided missiles.

Maintenance equipment for ordnance items.

Training materials.

Mobile ordnance equipment for handling munitions to and from aircraft on aircraft carriers and at shore bases.

The Bureau of Aeronautics has cognizance over all items installed in the aircraft by the aircraft manufacturer. This equipment is classified as armament equipment and includes the following:

Aircraft gun accessories (except those specified as under BuOrd); gun chargers; trigger switches and gun-firing solenoids; gun heaters; and ammunition boosters, boxes, and chutes.

Rocket launchers.

Aircraft equipment used to suspend and to release bombs, aircraft torpedoes, mines, depth bombs, and similar munitions.

PUBLICATIONS

General

Technical publications issued by the various bureaus of the Navy Department are sources of important information for every man in the Navy. Publications by the Bureau of Ordnance, Bureau of Aeronautics, and Bureau of Naval Personnel concern Aviation Ordnancemen. The most important publications from these sources with which the Aviation Ordnanceman striker and petty officer should be familiar are discussed in this section.

Bureau of Ordnance Publications

The *Bureau of Ordnance Manual* contains a chapter by chapter treatment of each type of ordnance equipment and material, including a general basic description of the item together with general basic operating and maintenance information. This manual is commonly referred to as the

"Ordnanceman's Bible," and is issued as a supplement for the amplification of *Navy Regulations.*

Chapters 10 and 14 of the *Bureau of Ordnance Manual* contain the most pertinent information as far as the Aviation Ordnanceman is concerned. These chapters are titled "Aviation Ordnance Equipment" and "Handling and Storage of Ammunition and Explosives."

The *Bureau of Ordnance Manual*, like all Bureau of Ordnance publications, is kept up-to-date by revisions issued by the Bureau in the form of NavOrd Instructions.

The *Index of Ordnance Publications* is a listing of all types of unclassified and confidential ordnance publications stocked for issue by the Bureau of Ordnance.

Part 1 of the *Index* comprises a NUMERICAL LISTING of all current publications and includes the following information concerning each publication: Type of publication, date of issue, security classification of material, and other pertinent information listed in the "remarks" column.

Part 1A is a listing by number and type of publication of all obsolete, canceled, and superseded publications.

Part 2, called the Subject Index is an alphabetical listing of all publications by subject.

The *Index of Ordnance Publications* is listed as *Ordnance Pamphlet 0.*

Ordnance Pamphlets (OP's) are used by ordnancemen more than any other type of publication issued by the Bureau of Ordnance. The OP is a basic publication which may be issued on a SPECIFIC ITEM of ordnance equipment, or on a specified SUBJECT pertaining to ordnance. When issued for a specific item of ordnance equipment, complete information on the operation, maintenance, repair, and detailed descriptions will be supplied. When complete information is desired about either a piece of ordnance equipment or a specific subject concerned with ordnance, the OP is the place to find that information. OP's are issued in numerical sequence regardless of subject or year of issue. OP 1866—*20-mm Aircraft Gun Mk 12 Mod 0*—is an example of an OP issued on a specific item of ordnance equipment. OP 1118—*Instruc-*

tions for Installation of U. S. Navy Mines in U. S. Naval Aircraft—is an example of an OP issued on a specific subject.

All currently effective OP's are listed in numerical order in Part 1 of OP 0—*Index of Ordnance Publications*—and alphabetically by subject in Part 2 of the *Index*.

NavOrd Directives. The Bureau of Ordnance issues two types of directives—*NavOrd Instructions* and *NavOrd Notices.* NavOrd Instructions and Notices have replaced other directive-type publications—OCL's, OTI's, OHI's, and OMI's—which have been issued in the past.

NavOrd Instructions are directives which contain information of a continuing nature. Instructions are numbered according to SUBJECT CLASSIFICATION AND ORDER OF ISSUANCE. The subject classification numbers for aviation ordnance are as follows:

8600–8799	AVIATION ORDNANCE
8600	General
8610	Fire Control
8620	Radar
8630	Ammunition
8640	Pyrotechnics
8650	Rockets
8660	Bombs and Bombsights
8670	Depth Bombs
8680	Torpedoes
8690	Mines
8700	Fuzes
8710	Guns and Mounts

CONSECUTIVE NUMBERS are assigned to Instructions in the order of issuance within each numbered subject group. A decimal point is placed after the subject number and followed by the consecutive number. Example: The subject number for pyrotechnics is 8640. The Bureau of Ordnance would assign numbers to the first, second, and third Instructions issued on pyrotechnics as follows: 8640.1, 8640.2, and 8640.3.

All operating activities will file Instructions in numerical order of subject classification numbers. Since all Instructions do not receive the same distribution, there will be gaps in the numbers of Instructions received by individual ships and stations. Check lists of all Instructions currently in effect are issued by the Bureau quarterly.

NavOrd Notices are directives of a one-time nature, or which require action to be completed immediately. Notices are numbered by subject classification only and ordinarily are not filed in a permanent file by receiving activities.

Bureau of Aeronautics Publications

Naval Aeronautic Publications Index (NavAer 00–500) is issued annually, listing all publications of the various bureaus and offices of the Navy Department which are of interest to naval aviation activities.

Each annual issue is kept up-to-date by cumulative supplements issued periodically. These supplements list publications issued, revised, or reissued since issuance of the current basic Index.

Corrections, changes, notes, and other information of miscellaneous or special nature which are not otherwise provided for in the Index or its supplements are listed on a page titled "The Index Bulletin," at the beginning of the supplement.

Instructions for using the Index are found on pages one and two.

Maintenance Manuals are issued for each specific model or series of models of service aircraft and contain useful information for all maintenance personnel. The sections on "General Maintenance" and "Useful or Military Load" concern the Aviation Ordnanceman. Included in the section on "General Maintenance" are instructions for the maintenance, removal, installation, and repair of all the armament equipment. Also included in this section is the procedure for boresighting the guns and sights. The section on "Useful or Military Load" gives complete loading instructions for all types of explosives to be carried by the aircraft.

Flight Handbooks are issued in the same manner as the Maintenance Manuals. This handbook is intended primarily for the pilots' use; however, much valuable information pertaining to ordnance and armament equipment is included. Instructions for operating guns, dropping bombs, torpedoes, firing rockets, operating sights, gun heaters, or any other operating equipment attached to the aircraft are included.

Armament Manuals are the ordnanceman's maintenance handbooks for armament equipment just as the OP's are for ordnance equipment. Issued either by the Bureau of Aeronautics, or jointly by the Bureau of Aeronautics and the Secretary of the Air Force, *Armament Manuals* supply the Aviation Ordnancemen with complete information on the operation, maintenance, and overhaul of all aircraft armament equipment.

A complete listing of all current Aircraft Armament Manuals may be found in the ARMAMENT SECTION of the *Aeronautic Publications Index.*

Technical Orders (TO's) are orders of a technical nature issued in letter form at irregular intervals either by the Bureau of Aeronautics or the Deputy Chief of Naval Operations (Air). TO's are mandatory orders and are to be executed in the manner called for on all aircraft or equipment to which they apply. All commands operating aircraft are required to maintain a complete file of all effective TO's. TO's are numbered consecutively as issued on a calendar year basis. TO 20–53 indicates the twentieth TO issued in the year 1953.

TO–0—issued annually—lists in numerical order all current and canceled Technical Orders. This same information may be found in the *Naval Aeronautic Publications Index* and the supplement.

Technical Notes (TN's) contain technical data of an operational or maintenance nature concerning aircraft or equipment. They are issued at irregular intervals for informational purposes and are suggestive rather than mandatory. All commands operating aircraft are required to maintain a complete file on those in effect. TN's are numbered in the same way as TO's.

TN-0—issued annually—lists in numerical order all current and canceled Technical Notes. This same information may be found in the *Naval Aeronautics Publication Index* and the supplement.

Aircraft Armament Changes (AAC's) describe mandatory changes or modifications to specific items of armament equipment. An AAC is issued when a piece of equipment proves inadequate or unsatisfactory and a new item, or a modification of the old one, has been developed which will improve its performance. Aircraft Armament Changes are numbered consecutively as issued. A complete listing of all AAC's issued, together with date of issue, those canceled, and those still in effect may be found in the Armament Section of the *Naval Aeronautic Publications Index.*

Aircraft Armament Bulletins (AAB's) are issued for specific items of armament equipment in the same manner as AAC's; however, these are more of a suggestive nature than mandatory. Suggested lubrication procedures, boresight procedures, or equipment changes which may be incorporated if desired are examples of armament bulletins. Like armament changes, AAB's are numbered consecutively and listed in the *Naval Aeronautic Publications Index.*

Aviation Circular Letters (ACL's) contain instructions regarding policy, administration, and air operations. They are numbered consecutively for each calendar year.

ACL-0—issued annually—lists in numerical order all current and canceled ACL's. This same information may be found in the *Naval Aeronautic Publications Index* and the supplement.

The Bureau of Aeronautics issues Instructions and Notices that are similar in nature to the directives of other Bureaus. BuAer Instructions and Notices are replacing other directive-type publications—TO's, TN's and ACL's—which have been issued in the past.

Bureau of Naval Personnel Publications

NAVY TRAINING COURSES.—Navy Training Courses are prepared and issued for the enlisted men of the Navy. Training courses contain information which will be helpful in the performance of your duties, as well as information necessary for advancement in rate.

This book (NavPers 10345) contains information for the Aviation Ordnancemen third and second class. Certain fundamentals common to other ratings as well as Aviation Ordnancemen, such as fundamentals of electricity, blueprint reading, mathematics, and use of hand tools are covered in the training courses listed below.

Electricity, NavPers 10622–B. A basic reference for all enlisted men of the Navy whose duties require them to have a knowledge of the fundamentals of electricity. Contains information required of Aviation Ordnancemen such as how to read circuit diagrams, use of Ohm's Law, how to solve for unknown values, and use of measuring instruments and other test equipment.

Mathematics, NavPers 10069–A and NavPers 10070–A. Valuable references in mathematics fundamentals, containing self-tests for evaluating your knowledge. Aviation Ordnancemen should be able to solve problems dealing with ratio and proportion, areas and volumes, and simple equations.

Blueprint Reading, NavPers 10077. A valuable reference on the fundamentals of blueprint reading.

Basic Hand Tool Skills, NavPers 10085. Contains valuable information on the care and use of hand tools used in all naval aviation ratings.

NAVY TRAINING COURSES are revised from time to time by the Training Division of the Bureau of Naval Personnel. Current issues are available through your Training Officer, regardless of the type of organization to which you belong.

Manual of Qualifications for Advancement in Rating. Another publication issued by the Bureau of Naval Personnel, and of interest to all enlisted men, is the *Manual of Qualifications for Advancement in Rating*, NavPers 18068. This manual sets forth the minimum qualifications required of enlisted personnel for advancement in rate or rating. Excerpts from the Qualifications Manual, listing the qualifications for Aviation Ordnancemen, have been included as appendix II of this book.

PROCUREMENT AND DISTRIBUTION OF EQUIPMENT

Ordinarily supply work throughout the Navy is handled by supply personnel, but it must be remembered that supply points cannot guess the actual needs of an operating squadron, or the individual needs of a department within an activity. It is therefore necessary for all men in aviation to become acquainted with the supply system. In aviation ordnance we find our job in supply a very important one. If attached to a FASRon or other service activity, we are charged with the responsibility of adequately supporting all the aircraft squadrons in the specific command. To support these squadrons it is necessary to maintain an ordnance storeroom. To maintain a properly supplied storeroom, an ordnanceman must be fully acquainted with the current supply system, requisitioning forms, and inventory forms.

Chain of Supply

The Bureau of Ordnance has its own distributive organization for aviation ordnance equipment under its cognizance. These activities are designated by BuOrd both as to location and purpose, and are classified as follows:

RESERVE SUPPLY POINTS.—A reserve supply point provides storage for reserve material and for excess quantities of active aviation ordnance equipment. BuOrd directs the manufacturers to ship the finished product to one of these reserve supply points. Examples of reserve supply points are the Naval Supply Depots at Mechanicsburg, Pa., and at Clearfield, Utah.

DISTRIBUTION POINTS.—A distribution point is defined as a ready-for-issue point where the equipment is broken down from the original bulk condition to the ready-for-issue condition. It is then held on board until BuOrd shipping orders are received. Examples are the depots at Norfolk and Oakland.

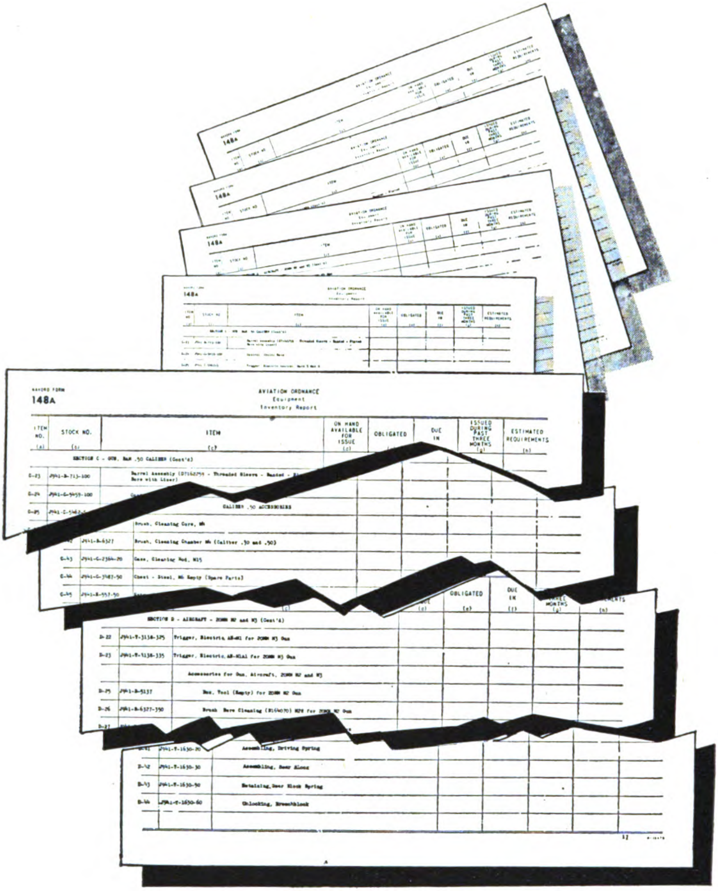
PRIMARY SUPPLY POINTS.—A primary supply point distributes aviation ordnance equipment among its secondary supply points, its dependent operating activities, and the overhaul and repair shops in accordance with Bureau of Ordnance policies.

SECONDARY SUPPLY POINTS.—A secondary supply point issues aviation ordnance equipment to its dependent operating activities.

A complete list of supply and storage points currently designated by BuOrd appears in OP 1820, *Supply of Aviation Ordnance Equipment.*

REPLENISHMENT OF PRIMARY SUPPLY POINTS.—Looking back over the last few paragraphs, it can be seen that the Bureau of Ordnance has complete control of the aviation ordnance equipment through the reserve supply points and distribution points. Replenishment of these activities is automatic when considered necessary by BuOrd. While BuOrd knows the types and quantities of equipment that have been shipped to the various primary supply points, they have no idea what equipment the primary supply points issue to secondary supply points and operating activities. As a result, the primary supply points are required to complete NavOrd Form 148B—Field Reporting Card BuOrd Class J94—quarterly and submit to BuOrd. From this report BuOrd can determine the needs of the primary supply points for the next quarter and will authorize a distribution point to ship the aviation ordnance equipment concerned. From this use of NavOrd Form 148B, primary supply points receive automatic quarterly shipments of equipment; however, there are times when the equipment supplied to the primary supply points proves insufficient, because of miscalculations, emergencies, and the like. When this happens the primary supply point may request an interim replenishment of stocks needed by submitting Supply and Accounts Form 220 to the Bureau of Ordnance for approval.

REPLENISHMENT OF SECONDARY SUPPLY POINTS.—Secondary supply points submit NavOrd Form 148B quarterly; however, they will submit this form to their supporting primary supply point instead of BuOrd. In this way the secondary



NAVORD FORM
148A

AVIATION ORDNANCE
Equipment
Inventory Report

ITEM NO. (a)	STOCK NO. (b)	ITEM (c)	ON HAND AVAILABLE FOR ISSUE (d)	OBLIGATED (e)	DUE IN (f)	ISSUED DURING PAST THREE MONTHS (g)	ESTIMATED REQUIREMENTS (h)
		SECTION C - GUN, BAR .50 CALIBER (Cont'd)					
C-23	J941-B-713-100	Barrel Assembly (D7162259 - Threaded Sleeve - Banded - Bore with Liner)					
C-24	J941-G-5459-100						
C-25	J941-C-5462-						
		CALIBER .50 ACCESSORIES					
		Brush, Cleaning Core, M-					
	J941-B-6327	Brush, Cleaning Chamber M- (Caliber .30 and .50)					
C-43	J941-C-2364-20	Case, Cleaning Rod, M15					
C-44	J941-C-3487-50	Chest - Steel, M- Empty (Spare Parts)					
C-45	J941-B-557-50						
		SECTION D - AIRCRAFT - 20MM M2 and M3 (Cont'd)					
D-22	J941-T-3138-325	Trigger, Electric, AN-M1 for 20MM M3 Gun					
D-23	J941-T-3138-335	Trigger, Electric, AN-M1A1 for 20MM M3 Gun					
		Accessories for Gun, Aircraft, 20MM M2 and M3					
D-25	J941-B-5137	Box, Tool (Empty) for 20MM M2 Gun					
D-26	J941-B-6327-350	Brush Bore Cleaning (B164070) M28 for 20MM M2 Gun					
D-27							
D-41	J941-T-1630-20	Assembling, Driving Spring					
D-42	J941-T-1630-30	Assembling, Sear Block					
D-43	J941-T-1630-50	Retaining, Sear Block Spring					
D-44	J941-T-1630-60	Unlocking, Breechblock					

Figure 1–1.—NavOrd Form 148A.

supply points also receive automatic quarterly shipments of aviation ordnance equipment. For interim replenishments, NavSandA Form 220 is submitted to the primary supply point.

NavOrd Form 148A is an ANNUAL REPORT of all ordnance equipment on hand and is submitted by all activities, including the actual users of the equipment. Operating and service squadrons submit this report to the station at which they are based. This report does NOT include equipment already installed in aircraft. The air stations consolidate these reports and their own report into a master form 148A and submit to their naval air base command. The naval air base command consolidates the reports for the entire command and submits to BuOrd not later than 15 July annually.

CLASSIFICATION OF MATERIAL AND EQUIPMENT

Materials and equipment are classified for cataloging according to their general physical characteristics and uses. This system, called the Navy Material Classification System, segregates naval stores and material into 99 DIFFERENT CLASSES, each class representing a type of material. The complete list appears in the *Catalog of Navy Material.*

Classes 1, 2, and 3 contain general service ordnance equipment such as major caliber guns, small arms, underwater weapons, and associated equipment.

Class 4 contains ammunition, bombs, warfare chemicals, pyrotechnics, and explosives (excluding rockets).

Classes 5 through 79 contain standard Navy items, such as tools, office supplies, cleaning supplies, and the like.

Class 94 material, which comprises aircraft armament and ordnance (except explosives and ammunition), is the chief concern of the Aviation Ordnanceman. Since cognizance of this material is divided between BuAer and BuOrd, letter prefixes are used. to distinguish between the two. Class J94 identifies AVIATION ORDNANCE EQUIPMENT. Class R94 identifies AVIATION ARMAMENT EQUIPMENT. Stock numbers are used for further identification of materials and equipment.

The BuOrd Section of the *Catalog of Navy Material* (Sections 6000–6900) is an alphabetical listing of all class J94 equipment. Each section has a component breakdown table which lists all parts of a major assembly. Stock numbers, part numbers, and places where the part is used are also given. Each assembled unit of ordnance equipment is further identified by a MARK NUMBER and a MODIFICATION NUMBER.

Aviation Supply Office Section (ASO) of the *Catalog of*

Navy Material carries all classes of equipment under the Bureau of Aeronautics control. Classes R5–R77 (standard aviation equipment), R80–R93 (parts peculiar to aviation), and R94 (aviation armament equipment) are the specific classes cataloged. All items are listed alphabetically by classes. To find the stock number of an item, first determine its material class. Turn to that class and by using the alphabetical index obtain its item number; then go through the material class to locate the item number and its corresponding stock number.

ALLOWANCE LISTS

ALLOWANCE LISTS are prepared by the various bureaus of the Navy Department for use as guides as to the type and quantity of material to be carried on hand by the various types of naval activities. Since the equipment with which aviation ordnance personnel primarily work comes under the cognizance of the Bureau of Aeronautics and the Bureau of Ordnance, the Aviation Ordnanceman is concerned with allowance lists issued by both these Bureaus.

BUREAU OF ORDNANCE ALLOWANCE LISTS.—The Bureau of Ordnance issues its allowance lists in the form of NavOrd Lists, each list being identified by a five-digit number. NavOrd Lists of major interest to the Aviation Ordnanceman are listed below:

NavOrd List 21416—*Line Maintenance and Spare Parts Sets.*

NavOrd List 21486—*Aviation Ordnance Allowance for Ships.*

NavOrd List 20870—*Aviation Ordnance Allowance for Naval Aircraft.*

BUREAU OF AERONAUTICS ALLOWANCE LISTS.—The Bureau of Aeronautics identifies and issues allowance lists of equipment under their cognizance in the form of SECTIONS. The Sections of major interest to ordnance personnel are:

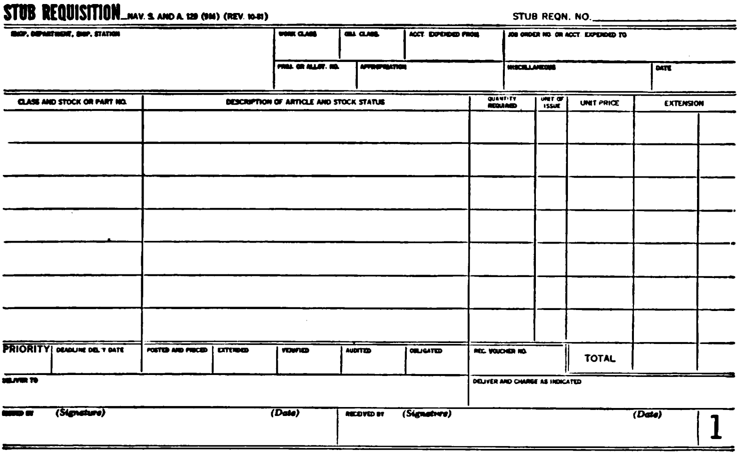
Section A—*Standard Aeronautical and General Stores Material.*

- Section B—*Aircraft Maintenance Parts for Designated Specific Model Aircraft.*
- Section G—*Shop Handling and Servicing Equipment.*
- Section K—*NavAer Publications and Forms.*
- Section O—*Aviation Armament Material, Arming and Gunnery Training.*
- Section P—*Photographic Equipment.*
- Section U—*Standard Hand Tool Kits.*

REQUISITION FORMS

Since all naval activities draw equipment from central supply points it is easy to see why standardized requisition forms are used. Besides the standard forms covered here, there are numerous local type forms in use. These local forms are issued by local supply activities to simplify the process of requisitioning material. However, when local forms are used, the supply activity must complete standard forms on the items issued.

SUPPLY AND ACCOUNTS FORMS 129 AND 129A are the standard forms used by all shore based activities in requisitioning material. Form 129 is commonly referred to as the STUB



STUB REQUISITION—NAV. S. AND A. 129 (9M) (REV. 10-81)

STUB REQN. NO.

SHIP, DEPARTMENT, SHIP. STATION

WORK CLASS

ACCT. EXPENDED FROM

JOB ORDER NO. OR ACCT. EXPENDED TO

FUND OR ALLOT. NO.

APPROPRIATION

MISCELLANEOUS

DATE

CLASS AND STOCK OR PART NO.	DESCRIPTION OF ARTICLE AND STOCK STATUS	QUANTITY REQUIRED	UNIT OF ISSUE	UNIT PRICE	EXTENSION

PRIORITY

DEADLINE DEL'Y DATE

POSTED AND PRICED

EXTENDED

VERIFIED

AUDITED

OBLIGATED

REC. VOUCHER NO.

TOTAL

DELIVER TO

DELIVER AND CHARGE AS INDICATED

ISSUED BY (Signature) (Date)

RECEIVED BY (Signature) (Date)

1

Figure 1–2.—Nav. S. and A. Form 129, Stub Requisition.

REQUISITION. The most important thing to remember when completing a stub requisition is that only one class of material may be ordered on any one stub. Form 129A is similar to Form 129, except it is canary yellow in color, and can be used to return material for credit. In case Form 129A is not available for use, then Form 129 may be used by checking the appropriate block.

SUPPLY AND ACCOUNTS FORM 43 is the standard form used by all forces afloat to draw equipment within their allowance.

AMMUNITION STOCK RECORDING SYSTEM

The ammunition stock recording system was established to provide the Ordnance Stock Office (OSO) with a standard system of recording all transactions involving ammunition and ammunition components and of providing accurate, up-to-date information on quantity and quality of ammunition on hand. All ammunition supply points operate under this system. This includes naval air station magazines and upward through the naval ammunition depots.

This system is under the control of the Ordnance Stock Office which is a section of the Bureau of Ordnance.

The principal forms used under the system are described here. For a complete description of all forms, refer to OP 1675—*Ammunition Stock Recording System, Manual of Instruction.*

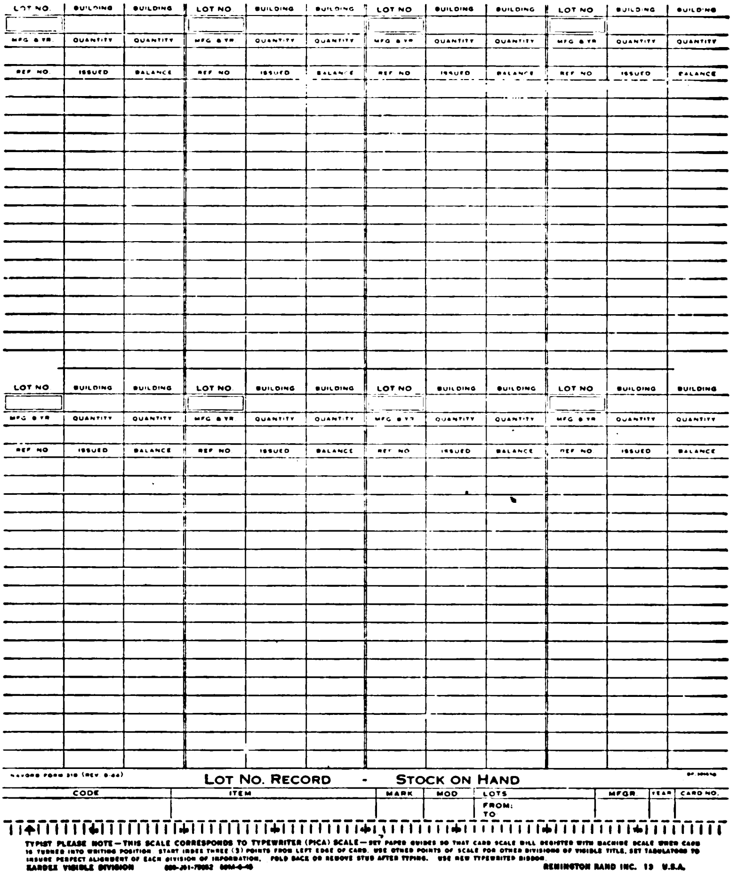
Ammunition Stock Record Card

Ammunition stock record cards are used within the station records office to provide a record of the on hand balance and history of the transactions of each item of ammunition carried by the station. The three forms of record cards are:

NavOrd Form 281—Fixed cartridges
NavOrd Form 282—Miscellaneous
NavOrd Form 1157—Semi-fixed cartridges

Magazine Cards

NavOrd Form 421—Miscellaneous
NavOrd Form 422—Gun ammunition



LOT NO.	BUILDING	BUILDING	LOT NO.	BUILDING	BUILDING	LOT NO.	BUILDING	BUILDING	LOT NO.	BUILDING	BUILDING
MFG & YR.	QUANTITY	QUANTITY	MFG & YR.	QUANTITY	QUANTITY	MFG & YR.	QUANTITY	QUANTITY	MFG & YR.	QUANTITY	QUANTITY
REF NO.	ISSUED	BALANCE	REF NO.	ISSUED	BALANCE	REF NO.	ISSUED	BALANCE	REF NO.	ISSUED	BALANCE

LOT NO.	BUILDING	BUILDING	LOT NO.	BUILDING	BUILDING	LOT NO.	BUILDING	BUILDING	LOT NO.	BUILDING	BUILDING
MFG & YR.	QUANTITY	QUANTITY	MFG & YR.	QUANTITY	QUANTITY	MFG & YR.	QUANTITY	QUANTITY	MFG & YR.	QUANTITY	QUANTITY
REF NO.	ISSUED	BALANCE	REF NO.	ISSUED	BALANCE	REF NO.	ISSUED	BALANCE	REF NO.	ISSUED	BALANCE

LOT NO. RECORD - STOCK ON HAND

CODE	ITEM	MARK	MOD	LOTS	MFGR.	YEAR	CARD NO.
				FROM: TO			

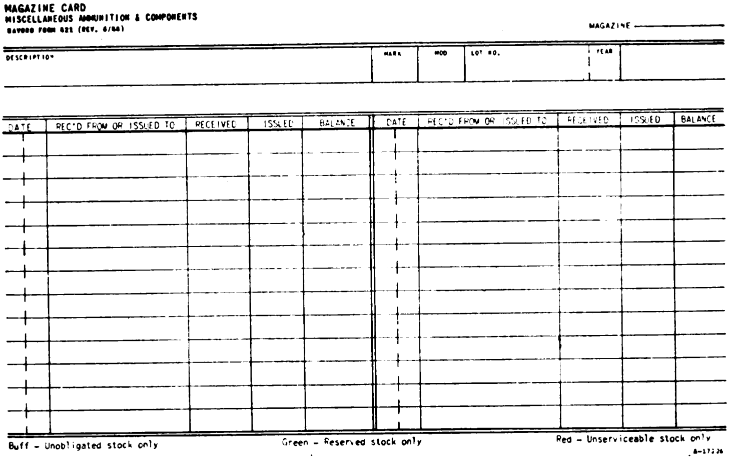
TYPIST PLEASE NOTE—THIS SCALE CORRESPONDS TO TYPEWRITER (PICA) SCALE—SET PAPER GUIDES SO THAT CARD SCALE WILL REGISTER WITH MACHINE SCALE WHEN CARD IS TURNED INTO WRITING POSITION. START INDEX THREE (3) POINTS FROM LEFT EDGE OF CARD. USE OTHER POINTS OF SCALE FOR OTHER DIVISIONS OF VISIBLE TITLE. SET TABULATORS TO INSURE PERFECT ALIGNMENT OF EACH DIVISION OF INFORMATION. FOLD BACK OR REMOVE STUB AFTER TYPING. USE NEW TYPEWRITER RIBBON.

KARDEX VISIBLE DIVISION REMINGTON RAND INC. 13 U.S.A.

Figure 1–3.—Stock record card.

A magazine card is attached to each stow of ammunition, indicating the quantity and full description of the ammunition therein. These cards are colored so that they show at a glance the status of each stock pile.

Buff—Unobligated stock
Green—Reserved stock
Red—Unserviceable stock



MAGAZINE CARD
MISCELLANEOUS AMMUNITION & COMPONENTS
NAVORD FORM 821 (REV. 6/48)

MAGAZINE ____________

DESCRIPTION	MARK	MOD	LOT NO.	YEAR	

DATE	REC'D FROM OR ISSUED TO	RECEIVED	ISSUED	BALANCE	DATE	REC'D FROM OR ISSUED TO	RECEIVED	ISSUED	BALANCE

Buff – Unobligated stock only　　Green – Reserved stock only　　Red – Unserviceable stock only

A-17136

Figure 1–4.—Magazine card.

QUIZ

1. Aviation Ordnancemen are responsible for the maintenance of all the ____________ and ____________ equipment used by naval aircraft.

2. A group of squadrons operating as a unit aboard a carrier is known as a ____________________ ____________________ group.

3. What is a fleet air wing?

4. An aircraft squadron is usually organized into what five departments?

5. What is a FASRon?

6. What are the two types of FASRons?

7. The aviation ordnance division of a naval air station is part of the station ____________________ department.

8. The aviation ordnance unit abroad a carrier is part of the ____________________ department of the ship.

9. Cognizance of aviation ordnance and armament equipment is divided between the Bureau of ____________ and Bureau of ____________________.

10. What publication is issued under the number OP 0?

11. NavAer 00–500 is what type publication?

12. In what section of the *Catalog of Navy Material* would you find Class J94 equipment?

13. NavSandA Form 129 is also known as the ____________________________________.

14. All ammunition supply points operate under the____________________ ____________________ system.

CHAPTER 2

EXPLOSIVES

An explosion is broadly defined as a rapid and violent release of energy. In this chapter, however, the term EXPLOSION is restricted to what happens when a gun is fired or when a missile is detonated. In all such explosions, the original explosive substance (either a solid or liquid) is rapidly transformed into gases of equal weight, but of many times greater volume than the original substance. In order to obtain such an explosive reaction, a suitable amount of heat or shock is applied.

From the above description of an explosion, an EXPLOSIVE may be defined as a substance which undergoes a sudden chemical change when subjected to a certain amount of heat or shock. This chemical change is characterized by the formation of large quantities of gas and a considerable amount of heat. These conditions must be accomplished very rapidly and the explosive substance must be confined in a limited space in order to obtain the desired result. A true explosive reaction proceeds at high velocity, liberates heat, creates gases, and develops high pressures.

The chief characteristic which distinguishes an explosive reaction from ordinary combustion is the high velocity of the explosive reaction. This is known as the RATE OF DETONATION and is measured by finding the time required by the explosive wave to travel a known distance in a tube in which the explosive has been packed. The rate of detonation is of prime importance and varies from 3 feet per second for smokeless powder to 22,300 feet per second for TNT. (There are other military explosives that have a higher rate of detonation than TNT.)

Also of great importance, especially in military explosives, is the SENSITIVITY. The explosive must be "safe" until the impulse is applied to start the reaction, or detonation; if the substance is so unstable as to react in response to a slight blow, friction, or pressure, it can have no practical application. Explosives vary in the strength of the impulse required to cause them to explode. Some are exploded at the slightest touch; others, such as fulminate of mercury, require a moderate blow or flame, and still others require a very violent blow and cannot be exploded in the open by a flame. It was originally considered that the power of an explosive was measured by the sensitivity and that the most powerful explosives were quite sensitive; but it has been found that insensitive explosives are quite powerful and that the SAFEST explosives are those (such as TNT and Explosive D) which, under ordinary circumstances, require a detonator to initiate the reaction.

Explosives cannot be classified definitely from their chemical composition, by the gas evolved, or the heat liberated. Consequently, they are classified by the speed of the chemical change (rate of detonation). If the velocity of the explosion can be controlled after the reaction starts, the explosive is classified as a PROPELLANT, that is, for use in ejecting a projectile from a gun. A propellant is generally termed a LOW EXPLOSIVE and is one which burns relatively slow and permits the initiating of action by flame.

When an explosive requires a powerful agent to start the reaction, and when the reaction is started, proceeds at a high rate, and is uncontrollable, it is considered a HIGH EXPLOSIVE. For example, TNT requires a powerful agent such as fulminate of mercury to start the reaction and is considered a high explosive. High explosives have a powerful disruptive action, and are used as burster charges in projectiles, bombs, and mines. They will be discussed later.

PROPELLANTS (LOW EXPLOSIVES)

Black Powder

Until the latter half of the nineteenth century when smokeless powder was developed, the only well-known explosive substance was black powder, which was used both for propellant and blasting purposes. From the best authorities it seems likely that the Arabs, about 1280 A. D., used mixtures similar to black powder, and by the sixteenth century the French had begun to grain it and classify it so that it could be used in various sizes of guns.

Saltpeter (sodium nitrate), sulphur, and charcoal have been the ingredients of black powder since the time of its first use as an explosive. All nations use practically the same proportions in the manufacturing process: 75 percent saltpeter, 15 percent charcoal, and 10 percent sulphur.

In manufacture, the ingredients are very finely pulverized, mixed together, and pressed to a high density. The resulting cake is then broken up and the individual grains rotated in a large drum to produce a glaze, thereby reducing the dangerous dust to a minimum. In some cases the cake is powdered and formed into grains of regular size.

As a propellant, black powder has four major disadvantages:

1. It leaves a large amount of residue, thus fouling the bore.
2. On being fired, it makes large quantities of black smoke.
3. It is very hygroscopic (that is, it absorbs water readily, an undesirable characteristic in explosives).
4. It causes considerable bore erosion by the high temperature of combustion.

Black powder is still in use in the Navy in various grades for the following purposes:

1. Fuze delay trains.
2. Igniters (in larger caliber gun ammunition).
3. Saluting charges.
4. Pyrotechnics.

5. Impulse charges for some torpedoes and depth charge throwers.

BLACK POWDER IS THE MOST DANGEROUS EXPLOSIVE IN SERVICE USE TODAY AND MUST BE HANDLED WITH EXTREME CAUTION.

Smokeless Powder

The first smokeless powder was made by a Major Schultze of the Prussian artillery in 1864. It was made of nitrated wood impregnated with saltpeter. Modern American smokeless powder is made of cellulose, the best source of which is cotton. Every nation now uses as propellants substances obtained from nitrocellulose, alone or mixed with nitroglycerin (such as cordite), as such substances permit controlling the rate of explosion. This is possible because the individual grains burn from the surface inward in successive layers, and by altering the size of the grain and thus changing the burning surface, the velocity of the reaction can be modified. Therefore, the same composition can be used in any size firearm merely by a change in the finishing process.

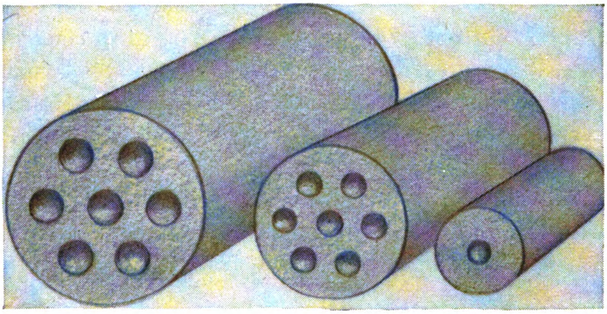


Figure 2–1.—Typical grains of smokeless powder.

The raw materials used in the manufacture of Navy standard smokeless powder are cellulose, nitric and sulphuric acids, ether, ethyl alcohol, and diphenylamine. Smokeless powder properly defined is "an ether alcohol colloid of nitrocellulose."

The burning rate is controlled by the size, shape, and web thickness of the grain. Web thickness is the distance between the holes (see fig. 2–1), and between the holes and the outer surface of the grain. One-hole grains are used in small caliber guns while seven-hole and rosette grains are used in larger caliber weapons. In manufacture, lots are blended to obtain uniform ballistics. Small arms lots range from 15,000 pounds to 50,000 pounds.

While conventional smokeless powder is in the shape of rods or cylinders, as shown in figure 2–1, a recent development is BALL powder. It is made like other smokeless powder but is formed into small round grains or balls instead of being pressed into strips which are then cut to the desired length. The balls are of various sizes for different requirements, and the burning rate is controlled by coating each grain with a slow-burning deterrent coating. When ignited, the coating burns slowly and, as it is consumed and the grains become smaller, they burn faster. This is known as progressive burning.

One of the greatest advantages of ball powder is that it packs more compactly in a cartridge case than does powder in the shape of rods and this permits an equivalent propellant charge to be loaded into a considerably smaller case with a corresponding reduction of size and weight in the complete cartridge. Most caliber .30 carbine cartridges are loaded with ball powder, and despite their small size and light weight, they have a muzzle velocity of close to 2,000 feet per second (see chapter 5).

The second major advantage of ball powder is that it produces less heat and erosion in barrels, thereby extending barrel life. This is particularly advantageous in automatic weapons.

As a propellant, smokeless powder has the following characteristics:

1. It burns evenly.
2. It is not corrosive, although it does have a tendency to absorb water.
3. It gives off large quantities of gas during burning.
4: It leaves little residue.

As can be seen, smokeless powder is a far better propellant than black powder, and is far less sensitive, tricky, and dangerous to handle. Nevertheless, certain precautions must be observed in handling it as specified in part below:

1. It must be stored in airtight, moisture-proof containers.
2. It must be kept below 90° F. in storage. The best temperature is 60° F.
3. It must be checked constantly for evidence of deterioration.

Powder magazines are therefore checked daily, as a matter of routine, for condition of powder containers, for maintenance of proper temperatures, and for deterioration of powder.

Smokeless powder is constantly being improved, especially with respect to elimination of muzzle flash, improving resistance to deterioration caused by temperature and moisture, and improving its burning characteristics. There has been considerable progress in developing flashless nonhygroscopic powder, designated as FNH. Nonhygroscopic powder is designated NH.

Ballistite

Ballistite is a double-base powder used as a rocket propellant. Its composition is 60 percent nitrocellulose, 39 percent nitroglycerin, and 1 percent diphenylamine. It burns with a considerable flash and much smoke, and generates a great volume of gas. Ballistite burns progressively at a slower rate than gun ammunition. It is ignited by a black powder charge which in turn is ignited electrically.

SPCG

SPCG is a later development of rocket propellant and is replacing ballistite as such. It is also used as a propellant in large caliber guns. It is composed of 50 percent nitrocellulose and 50 percent nitroguanadine. It is very cool burning with little smoke, no flash, and has a higher velocity than does ballistite.

DETONATING SUBSTANCES

A PRIMER is a device for initiating the burning of the propellant charge by means of a flame. In large caliber guns, the flame from the primer ignites a charge of black powder which in turn ignites the propellant charge. In small-arms ammunition, the flame from the primer alone is sufficient to ignite the propellant. The particular type of explosive used in a primer or detonator is called a **DETONATING SUBSTANCE**, the most common examples of which are **FULMINATE OF MERCURY** and **LEAD AZIDE**. Detonating substances are those which will detonate by the application of ordinary means, such as heat, impact, or friction, and will impart a percussion blow of such character as to detonate high explosives which cannot be detonated directly by ordinary means.

A **BOOSTER** is a secondary or intermediate detonating substance used with high explosives. It is a compound which is too insensitive to be detonated directly but is sensitive enough to be detonated by the initiator and to pass along the effects to the main charge. In the case of high explosives, the initiator would be a fuze or other denotating device. One of the most common boosters in use today is **TETRYL**, which will be discussed later.

Fulminate of Mercury

Fulminate of mercury was discovered in 1790 and was first used practically for the manufacture of percussion caps in 1815. The sensitivity is so great that accidents, especially in manufacture, are numerous, and frequent attempts have been made to find a suitable substitute. No such substitute, however, has replaced fulminate of mercury to any extent except lead azide which has been adopted for the detonators in some Navy large caliber base detonating fuzes, in all Army large caliber base detonating fuzes, and in commercial detonators.

Fulminate of mercury has the peculiar property, when struck or otherwise exploded, of igniting, then rapidly detonating, instead of instantly detonating as do other high explosives. It is used only as a detonating or primer compound. When used in primers it is generally mixed with other substances to increase the heat of the explosion, produce a longer flame, and vary the sensitivity.

Fulminate of mercury is adversely affected by moisture so fulminate detonators and ammunition containing fulminate primers must be kept dry. It will decompose in stowage in tropical temperatures and will be rendered useless in about three years. It is unaffected by variations of temperature in ordinary stowage.

Lead Azide

Lead azide is the most suitable of several azides which can be used as substitutes for fulminate of mercury. Lead azide is less sensitive and this quality makes it a better detonating substance for use in large caliber base detonating fuzes and some aircraft bomb fuzes. It is frequently mixed with fulminate of mercury.

Lead azide does not suffer an aging effect as does fulminate of mercury. This aging effect in fulminate reduces the sensitivity of the mixture after long periods of storage.

HIGH EXPLOSIVES

A HIGH EXPLOSIVE is an explosive substance whose reaction or decomposition, once started, is extremely rapid and uncontrollable. This type of explosion is called a high-order detonation. It has been shown that a low explosive burns at a much slower rate and is controllable.

The qualities of rate of detonation and sensitivity have already been discussed; however, a third quality of considerable importance in the consideration of high explosives is that of BRISANCE. Brisance can be defined as the shattering ability of an explosive. Brisance, however, has little to do with the strength or power of an explosive, which is measured by the quantity of heat and gas given off, but depends more on the rate of detonation.

Used as a bursting charge in a projectile or bomb, an explosive with too little brisance would break the casing into a few large but slow-moving and poorly distributed fragments. An explosive with too high a brisance would shatter the casing into such small fragments that they would be ineffective.

A high explosive for military use must fulfill certain requirements. It must be insensitive enough to withstand the shock of being fired from a gun, of handling, and of impact against armor. It must be stable in storage. It must be easy to load, manufacture, and handle, and must have maximum power.

Compromises have to be made on some of these points. As an example, TNT is definitely too sensitive to withstand an impact against armor, while Torpex is not combat safe—if struck by a projectile it will sometimes detonate.

TNT (Trinitrotoluol or Trinitrotoluene)

TNT has, for a number of years, been the explosive used as a main charge in practically all American bombs, projectiles, and other munitions, but it is being gradually replaced by newer, more powerful explosives. However, large quantities of munitions are still being loaded with TNT.

TNT is produced from toluol, or toluene, a coal tar derivative. Two grades, grade A and grade B, have been used in the Navy, with grade A being the purer. At present all TNT produced is grade A. TNT is relatively insensitive to shock, friction, or pressure. However, it is not insensitive enough to be used as a filler in armor-piercing projectiles or bombs. It melts readily, thus being very convenient to load into any type casing.

During storage, a dark brown, oily liquid called EXUDATE frequently separates out from TNT. The amount and rate of separation depends primarily on the purity of the TNT and secondarily on the temperature of storage. Grade B TNT, being less pure than grade A, has a considerable amount of exudation; this is its only disadvantage. Exudate is dangerous; it is inflammable and highly sensitive to percussion. Any accumulation of exudate presents both a fire and explosive hazard, and must be removed immediately. Exudate is soluble in acetone, and this solvent or clean hot water should be used to remove it. UNDER NO CIRCUMSTANCES SHOULD SOAP OR OTHER ALKALINE PREPARATIONS BE USED TO REMOVE EXUDATE.

Explosive D (Ammonium Picrate)

Explosive D is used as the main charge in armor-piercing bombs and projectiles because of its insensitivity. It is manufactured by saturating a solution of picric acid with aqua ammonia or ammonia gas, and is crystalline powder varying in color from orange to deep red.

Explosive D is less powerful than TNT but this disadvantage is offset by its insensitivity to shock, friction, and pressure. It has high chemical stability and is not affected by ordinary variations in temperatures; however, it is hygroscopic and will absorb up to 5 percent moisture, thereby losing power and sensitivity. In addition, it reacts with metals, especially when wet, and forms extremely sensitive compounds. To prevent this reaction, the inside of bombs and projectiles to be loaded with Explosive D are coated with an acid-proof lacquer.

Picratol

Picratol is composed of 52 percent Explosive D and 48 percent TNT, and is used as a main charge in semi-armor-piercing bombs. It is more impact-sensitive than Explosive D, but less than TNT. It is cast-loaded.

Tetryl

Tetryl is the accepted abbreviation for trinitrophenylmethylnitramine, a nitrocompound which is an excellent explosive for booster charges and is very widely used as such.

Tetryl is about 18 percent more powerful than TNT and more easily detonated. It is more sensitive to shock than TNT, but not sufficiently so to be dangerous, and is stable at all ordinary temperatures. It is expensive to manufacture, and cannot be cast-loaded. Tetryl is toxic and gloves must be worn when it is being handled to avoid tetryl poisoning.

Tetryl is easily detonated by the explosive wave from the initiator, this being one of the characteristics which makes it an excellent booster explosive. For the same reason, however, it is not used as a main charge except in certain small-caliber projectiles, such as the 20-mm.

Tetrytol

Tetrytol is composed of 70 percent tetryl and 30 percent TNT, and is used when a large quantity of booster explosive is desired. Its main advantages over tetryl are that it can be cast-loaded (tetryl must be press-loaded) and that it is less expensive. Tetrytol cannot be used where it will come in contact with hot explosives, such as a main charge being loaded in molten form into a casing, as it will be melted by the heat and separation will occur. This prevents its being used as an auxiliary booster in those bombs using such boosters.

Amatol

Amatol has been used as a substitute for TNT, when shortages of toluol have resulted in insufficient quantities of TNT being available. Amatol is made by melting TNT and incorporating ammonium nitrate, making a 50–50 or an 80–20 mixture of ammonium nitrate and TNT respectively.

PETN

PETN is an explosive more sensitive than tetryl but less so than fulminate of mercury. It is used mostly in the manufacture of primacord which is used as a detonating cord to detonate a charge, or series of charges simultaneously. Used in this manner it is mixed with wax, being too sensitive to be used in unadulterated form.

Primacord, which is used a great deal in demolition and disposal work, comes in 100-foot spools. It is ¼ inch in diameter and is flexible and waterproof. The outside of the cord is yellow; the explosive itself is white. Primacord is insensitive to flame, shock, and friction, and must be detonated by a blasting cap, either electric or nonelectric.

RDX (Cyclonite)

RDX used in several modern explosive mixtures, was developed by the British and reached practical application during World War II. It is produced by the nitration of an organic material and is in the form of crystals. These crystals are coated with wax to reduce sensitivity and, in this form, RDX may be handled readily. No further details of manufacture or materials used may be given.

RDX is far too sensitive to be used alone, and the addition of less sensitive materials is necessary before it can be used as a military explosive.

RDX is stable in stowage and may be press-loaded. It is the most powerful and brisant of military explosives, with the exception of nuclear fission weapons.

RDX Composition A

Composition A is composed of 91 percent RDX and 9 percent beeswax or similar wax by weight. It may be used as a projectile filler.

RDX Composition B

Composition B is a mixture of about 60 percent RDX and 40 percent TNT by weight, plus about 1 percent beeswax. It is used in most fragmentation bombs, and was used in some large general-purpose bombs during World War II due to a shortage of TNT. Large GP bombs loaded with Composition B should never be used in skip bombing due to its sensitivity, and such bombs are usually fuzed with instantaneous fuzes for the same reason.

Composition B is cast-loaded and TNT is used to provide a cushion between the Composition B and the bomb casing. This caution is known as a "surround."

One of the major uses of Composition B is in the production of Torpex and HBX.

RDX Composition C

Composition C is a mixture of approximately 88 percent RDX and 12 percent plasticizing oil. It is used in demolition work, can be molded or shaped in any form, and has the consistency of putty. It will retain its plasticity over a wide range of temperature and will not exude oil.

Torpex

Torpex was used during World War II as a main charge in underwater munitions such as depth bombs and charges, mines, and torpedoes. It is composed of 42 percent RDX Composition B, 40 percent TNT, and 18 percent aluminum powder by weight. Torpex, while much more sensitive than TNT, is also much more powerful; on a weight basis, 100 pounds of Torpex will produce the same underwater damage as approximately 150 pounds of TNT. It is nonhygroscopic, noncorrosive, and is stable in stowage. It is cast-loaded.

Torpex, however, has the great disadvantage of not being combat safe. When struck by small-arms projectiles, or projectile or bomb fragments, a low-order (and occasionally a high-order) detonation will usually occur.

HBX

HBX has superseded both TNT and Torpex in almost all underwater munitions. It is only 2 percent less powerful than Torpex, but is 50 percent less sensitive. It is cast-loaded and tests indicate it is as stable as TNT, although as yet there is no information as to its stability over a long period of stowage.

HBX is basically desensitized Torpex. It is composed of 40 percent RDX Composition B, 38 percent TNT, 17 percent aluminum powder, and 5 percent desensitizer. Early HBX absorbed moisture, and after doing so, gave off gas that caused pressure in the casting. To counteract this, 0.5 percent calcium chloride was added to the HBX which was then designated as HBX–1. HBX–1 is now in general use.

QUIZ

1. Explosives are classified by the speed of the ---------- ----------.
2. If the velocity of the explosion can be controlled after it is started, the explosive is classified as a ---------- or ----------.

3. What is the most dangerous explosive to handle used in the Navy today?
4. Define smokeless powder.
5. Name two detonating substances.
6. When the decomposition of an explosive substance is extremely rapid and is uncontrollable, it is termed a ---------- ---------- detonation.
7. What is the basic ingredient of TNT?
8. What should never be used to remove TNT exudate?
9. What explosive is used as a burster charge in armor-piercing bombs?
10. Tetryl is used mainly as a ---------- charge.
11. What explosive is now used in almost all underwater munitions?

CHAPTER 3

BOMBS AND MINES

An aircraft bomb ordinarily consists of a metal container or casing filled with explosives or chemicals; a means of stabilizing its flight (usually a fin assembly) so that it can be aimed accurately; fuzes for exploding the bomb at the target; and such safety devices as may be necessary to make it reasonably safe to carry. The bomb is usually streamlined, with a rounded nose and a tapered tail. The stabilizing device is attached to the tail, and generally consists of a sheet metal fin assembly, although a parachute or cloth streamers are occasionally used.

Aircraft bombs came into general use during World War I. They were crude at first, but by the end of the war had become quite modern looking, although small by present day standards. The 110-pound German airship bombs dropped on England were then considered large.

The tail fin assemblies on modern bombs are of two types, BOX TYPE and RING (OR SHROUDED) TYPE. Box FINS are used on all high-level bombs and are the type most commonly seen, generally being secured to the bomb body by a locking ring. RING, OR SHROUDED, FINS are used on depth bombs, and are attached to the bomb body by bolts.

The bomb casing is loaded through a BASE FILLING PLUG which is usually staked in to prevent subsequent removal. The bomb is suspended from the releasing device by SUSPENSION LUGS which are welded to the casing, except on armor-piercing and depth bombs, which have the suspension lugs bolted on. Most bombs have both DOUBLE and SINGLE suspension lugs, located 180° apart on the bomb body. Double lugs are spaced 14 inches apart on all bombs up to 1,600 pounds and 30 inches apart on all bombs of 2,000 pounds or over.

Bombs are hoisted into or onto aircraft by one of three methods: HOISTING LUGS, which are welded or bolted to the casing; HOISTING BANDS, which are secured around the bomb, and which have a hoisting lug welded to the band; and HOISTING SLINGS, which are steel cables used extensively by the Navy for hoisting Army-designed bombs.

NOTE: In this chapter, and in the chapters following, the designation AN will be applied to many types of ordnance and armament equipment and munitions. AN means ARMY–NAVY and indicates that an item has been standardized for joint use by both the Navy and Air Force. The letter M behind the AN (AN–M66) shows the item was an Army Air Forces (now U. S. Air Force) development. A Navy-developed item is indicated by Mk or Mark behind the AN, such as AN–Mk 230. Subsequent modifications to an Army (or Air Force) developed item are indicated by the letter A, followed by a number; for example, AN–M66A1 would indicate a first modification, AN–M66A2 the second modification, and so on. Modifications to a Navy-developed item are indicated by Mod (modification) followed by a number, such as AN–Mk 230 Mod 0, which would be the original design, AN–Mk 230 Mod 1, the first modification, etc.

Some of the internal components of bombs, in addition to the main burster charge, are listed below:

1. FUZE SEAT LINER—a metal sleeve, threaded internally to receive a fuze and used in the nose of Navy and Air Force bombs, and the tail of Navy bombs. It does not contain an integral explosive charge.

2. AUXILIARY BOOSTER (pellet-type)—a removable booster charge which fits into the fuze seat liner of Navy-type bombs.

3. AUXILIARY BOOSTER (tube-type)—a plastic tube filled with booster explosive. It is installed during the loading process and is not removable, being encased in the main charge. It extends from the fuze cavity toward the center

of the bomb, and is used in the nose and tail of most Air Force bombs.

4. ADAPTER BOOSTER—a metal sleeve, threaded internally and externally, and containing a booster charge in one end. The adapter booster is screwed into the base of Air Force bombs and is necessary on these because Air Force tail fuzes have no self-contained booster. The fuze is installed in the adapter, and on functioning, the primer detonator of the fuze explodes the adapter booster which in turn detonates the auxiliary booster and the main charge. There are both large and small types; the small type takes only Air Force fuzes while the large type will accommodate the larger-diameter Navy hydrostatic tail fuzes. The large type will also take Air Force fuzes by installing an internally threaded reducer. A later modification has a hole drilled in it for locking to the base plug by means of a locking pin. This prevents removal by the enemy when a long-delay fuze is installed.

Bombs are classified according to filler as HIGH-EXPLOSIVE, CHEMICAL, PRACTICE, and DRILL. Explosive bombs are classified according to use as GENERAL PURPOSE (GP), ARMOR-PIERCING (AP), SEMI-ARMOR-PIERCING (SAP), DEPTH (DB), and FRAGMENTATION.

The part of a bomb that does the damage is the explosive filler. If it is known what percentage of the weight of the bomb is taken up by the explosive charge, it can be fairly well determined what the bomb will do. This ratio of the weight of the explosive to the total weight of the bomb is known as the LOADING FACTOR. If the total weight of a bomb is 1,000 pounds, for example, and 500 pounds of this weight is explosive, the bomb's loading factor is 50 percent.

Bombs in service are marked to indicate type, weight, model, filler, lot number, loading plant, and date loaded. They are also painted a basic color representing the general type of filler.

GENERAL-PURPOSE BOMBS

General-purpose bombs, formerly known as demolition bombs, are used for the destructive effect caused by (1) blast, fragments, and vacuum pressures created by above-surface explosions, and (2) the mining effect, or earth shock, resulting from the detonation of buried bombs. GP bombs range in size from 100 pounds to 2,000 pounds and resemble each other closely. The cylindrical body tapers in an ogive to the nose, and in a straight cone to the base plug closing the tail end. It has box tail fins and fuze cavities fore and aft.

The loading factor of a GP bomb is fairly large—approximately 50 percent. The standard filler is TNT, although amatol and Composition B have been used in the past during shortages of TNT. The GP bomb has fair penetration and good fragmentation, and is used for attacks on unarmored vessels, submarines, aircraft, personnel, and most ground targets. The metal case is strong enough not to rupture on impact with normal soil when released from high altitudes, but it might fail on impact with heavy armor or high-strength reinforced concrete structures.

The GP bomb casing has sides from ¼- to ½-inch thick, with heavier nose and tail sections. Its maximum penetration is approximately ¾ inch of armor plate, and it will penetrate several decks of an unarmored ship or several floors of an ordinary building.

Both nose and tail fuzes are used in GP bombs (with the possible exception of the 100-pound bomb), the secondary fuze serving as insurance against malfunction. INSTANTANEOUS fuzes are used when maximum blast damage is desired, while DELAY fuzes are used to produce a mining effect. For emergency attacks on submarines or for other depth-bombing purposes when regular depth bombs are not immediately available, a hydrostatic tail fuze may be installed in some bombs to detonate at a preset distance beneath the surface.

A special type of GP bomb is the LIGHT-CASE bomb, which is similar to the standard GP but designed to carry a maximum explosive charge. The loading factor of a light-case bomb is in excess of 75 percent and, since the strength of the case has been sacrificed to maximum charge, it cannot be used for penetration but must be fuzed for instantaneous detonation. The light-case bomb is seldom used by the Navy.

General-purpose bombs are painted olive drab with black lettering and numbers. Those filled with TNT or amatol have a yellow nose band and tail band. Those filled with Composition B have two yellow tail bands in addition to the nose band. One of the tail bands has "COMP. B" stenciled on it.

Brief descriptions of the most commonly used general-purpose bombs follow.

100-Pound GP Bomb AN–M30A1

This bomb is made of either forged or cast steel and contains 53.7 pounds of TNT; the complete bomb weighs 109.5 pounds. Assembled, it is 40.3 inches long and 8.2 inches in diameter. It has both double and single suspension lugs which are welded on, and nose and tail fuze cavities. There is a tube-type auxiliary booster in the nose and a small-type adapter booster in the tail, which will take only Air Force tail fuzes. The most commonly used fuzes are AN–M103A1 (nose) and AN–M100A2 (tail). It has a staked-in base filling plug and a locking-pin hole in the adapter booster.

250-Pound GP Bomb AN–M57A1

This bomb is made of forged or cast steel and is filled with 124.6 pounds of TNT. The complete bomb weighs 260.9 pounds, is 47.8 inches long, and the body is 10.9 inches in diameter. It uses the same fuzes as the 100-pound GP bomb, and has both nose and tail tube-type auxiliary boosters. A small-type adapter booster is installed and as a result only Air Force type fuzes may be used in the tail. It has a staked-in base filling plug and a hole drilled in the adapter booster for a locking pin. (See fig. 3–1.)

500-Pound GP Bomb AN–M64A1

This bomb is also made of forged or cast steel and is normally loaded with 266.0 pounds of TNT. The total

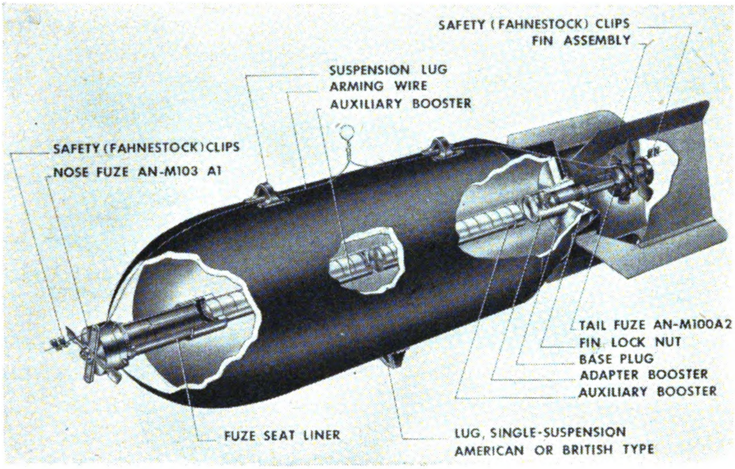


Figure 3–1.—250-pound GP Bomb AN–M57A1.

weight of the bomb is 457.4 pounds. It is 59.2 inches in length, and the body is 14.2 inches in diameter. It has both single and double suspension lugs welded on. It is generally fuzed with the AN–M103A1 nose fuze and the AN–M101A2 tail fuze, and has nose and tail tube-type auxiliary boosters. In the tail is installed a large-type adapter booster with reducer sleeve to accommodate both Air Force and Navy type fuzes. The base plug is staked in place and both adapter booster and reducer sleeve may be locked in place.

1,000-Pound GP Bomb AN–M65A1

This bomb follows the general description of other GP bombs. It is filled with 545.2 pounds of TNT and weighs a total of 1,052.8 pounds. It is 69.5 inches in overall length and the body is 18.8 inches in diameter. It is usually fuzed with the AN–M103A1 nose fuze and the AN–M102A2 tail fuze, and has tube-type auxiliary boosters fore and aft as well as a large-type adapter booster. As in other GP bombs designated A1, base plug and adapter booster are locked in. Double or single suspension may be used. (See fig. 3–2.)

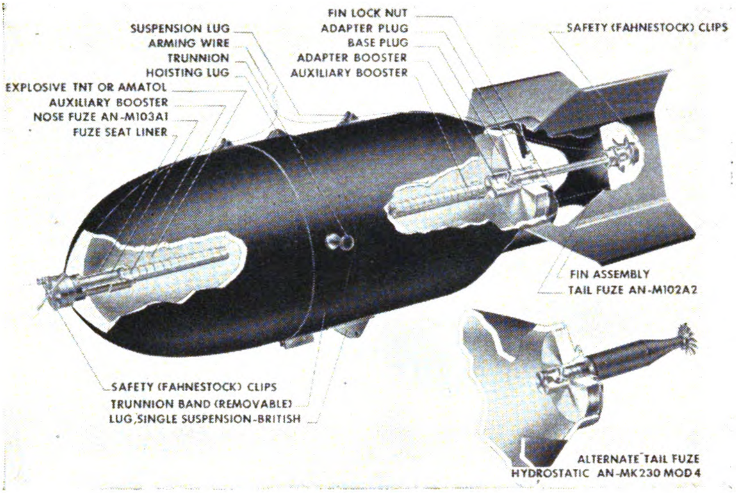


Figure 3–2.—1,000-pound GP Bomb AN–M65A1.

2,000-Pound GP Bomb AN–M66A1

The total weight of this bomb is 2,088.3 pounds, of which 1,097.2 pounds is TNT. Construction is like other GP bombs, including double and single welded-on suspension lugs. The bomb is equipped with nose and tail tube-type auxiliary boosters and a large-type adapter booster with reducer sleeve for Air Force fuzes. Both base plug and adapter booster and sleeve are locked in place. The fuzes normally used are the AN–M103A1 nose fuze and the AN–M102A2 tail fuze, although several others may be used if desired. The bomb is 92.8 inches overall in length and the body is 23.3 inches in diameter. The double suspension lugs are spaced 30 inches apart.

SEMI-ARMOR-PIERCING BOMBS

In appearance the SAP bomb resembles the GP but has a thicker case and a correspondingly smaller amount of explosive. Most SAP bombs are now loaded with picratol, although TNT and amatol have been used. When either TNT or amatol is used as a filler, the bomb has a wax pad in the nose to cushion the filler from impact and for this reason a nose fuze, if used, is not likely to function properly. SAP bombs have fuze cavities fore and aft, but a nose fuze is very seldom used because the impact against armor is too great to permit proper functioning. The nose fuze cavity is normally filled with a steel plug. When a nose fuze is used, it is generally the AN–M103A1, but nose fuzing is recommended only in cases of emergency when no suitable GP bombs are available. The same tail fuzes as are used in GP bombs are used in SAP bombs. To allow maximum penetration they are equipped with various delay primer detonators.

SAP bombs are painted olive drab with a yellow nose and tail band. Letters and numbers are black.

Brief descriptions of two common SAP bombs follow.

500-Pound SAP Bomb AN–M58A2

This is a cylindrical bomb 57.8 inches long, with a body 11.8 inches in diameter. The complete bomb weighs 536.5 pounds and the picratol filler weighs 143.1 pounds. It is made of cast or spun steel and is somewhat more streamlined than a GP bomb. The sides of the casing are 1½ to 2 inches thick with nose and tail sections 2½ to 3 inches thick. The casing has double and single welded-on suspension lugs. No auxiliary boosters are used but a small-type adapter booster is installed in the tail which will take Air Force fuzes only. The tail fuze used is usually the AN–M101A2 and, subject to the conditions noted earlier, the AN–M103A1 nose fuze may be installed after removing the steel nose plug. The AN–M58A1 SAP bomb was so designated to indicate a strengthened nose section, while the A2 designation indicates a staked-in base plug and a hole drilled in the adapter booster for a locking pin.

1,000-Pound SAP Bomb AN–M59A1

Construction of the 1,000-pound bomb is similar to the 550-pound SAP bomb. This bomb weighs 1,033.9 pounds, of which 312.6 pounds is picratol filler. Overall length is

70.4 inches, and body diameter is 15.1 inches. The casing has double and single welded-on suspension lugs. There is a tube-type tail auxiliary booster and a small-type adapter booster. The A1 designation indicates a staked-in base plug and adapter booster drilled for a locking pin. The tail fuze usually employed is the AN–M102A2, with delay primer detonator. The casing is proportionately thicker than that of the smaller 500-pound SAP. (See fig. 3–3.)

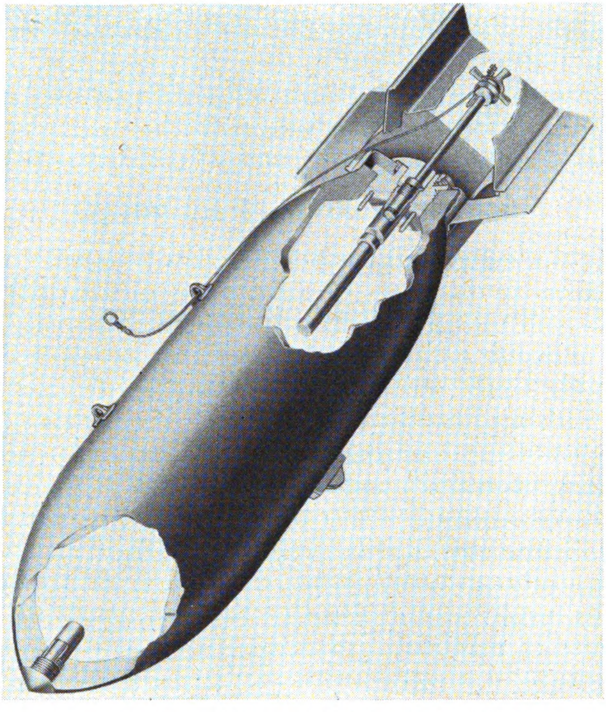


Figure 3–3.—1,000-pound SAP Bomb AN–M59A1.

ARMOR-PIERCING BOMBS

The armor-piercing bomb has been developed for use against the heaviest deck armor of modern battleships and is used in either dive or horizontal bombing. A heavy case is provided, with a long ogival nose section, heat-treated for greater strength. The outer surface of the bomb is machined to relative smoothness to reduce air resistance, and AP bombs are invariably long in comparison to their diameter.

Because of the heavy casing, the AP bomb has a very low loading factor of about 15 percent. The main charge is Explosive D (ammonium picrate) which is insensitive enough to withstand the impact against heavy armor. As AP bombs have a very heavy solid steel nose, they are fuzed in the tail only; the only fuze authorized is the AN–Mk 228 with a fixed 0.08-second delay.

An AP bomb has relatively little blast effect and does most of its damage by fragmentation. The heavy case shatters into several hundred pieces of metal and, while this may be less damaging than blast effect, it is nevertheless quite effective. Another effect of the low loading factor is that the AP bomb has practically no "near miss" or mining effect. A GP bomb detonated in the water near a ship will generate a wave of pressure through the water which will do great damage to the hull, while a similar detonation of an AP bomb has little effect.

If an AP bomb is used against unarmored or lightly armored vessels, it is likely to pass entirely through the target before exploding. A hit on a target often gives very little external evidence such as smoke or flash, as detonation occurs deep in the interior of the target, and the customary indications will not be visible immediately.

1,000-Pound AP Bomb AN–Mk 33

This bomb is 73.0 inches in overall length and has a body 12.0 inches in diameter. It weighs 1,000 pounds and is filled with 140 pounds of Explosive D. The designators, Mods 1, 2, and 3, of the AN–Mk 33 indicate different manufacturers and not design changes. Double and single suspension lugs and the hoisting lug are bolted to the bomb body. The body itself is made of machined steel with sides 4 to 6 inches thick, while the nose and tail sections are 8 to 10 inches thick. The nose section is heat-treated. This bomb is fuzed in the tail

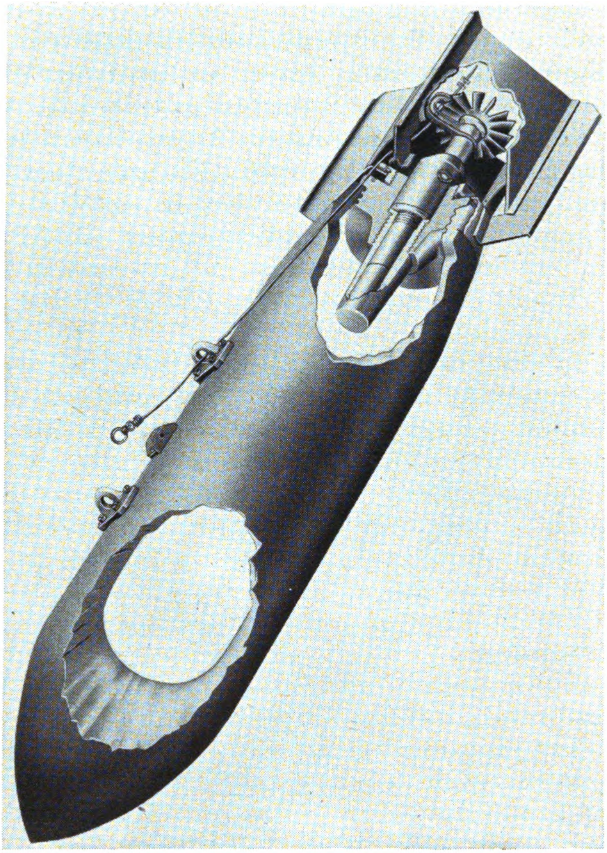


Figure 3–4.—1,000-pound AP Bomb AN–Mk 33.

only, using the AN–Mk 228 fuze. A pellet-type auxiliary booster is installed in the fuze cavity. This bomb uses 14-inch suspension. (See fig. 3–4.)

1,600-Pound AP Bomb AN–Mk 1

As with the AN–Mk 33, various modification numbers of this bomb indicate only different manufacturers. The bomb is 83.5 inches long overall and has a body 14.0 inches in diameter. It weighs 1,590 pounds and has a filler of 209.0

pounds of Explosive D. Construction and other details are the same as the AN–Mk 33 except that tapped holes are provided for 30-inch suspension if desired. The casing is also proportionately thicker. A pellet-type auxiliary booster is installed in the fuze cavity and the AN–Mk 228 tail fuze is used.

Painting and markings are the same as indicated for SAP and GP bombs.

DEPTH BOMBS

The aircraft depth bomb is a bomb designed for attacking submarines or underwater targets and was widely used during World War II. In the past they have ranged in size from 325 pounds to 700 pounds, but the only one used at present is the AN–Mk 54 Mod 1, weighing 350 pounds and loaded with HBX–1. It will be discussed later.

Depth bombs have a loading factor of about 70 percent and are armed either for impact or underwater explosion at a preset depth. Depth-setting is usually done before takeoff, although on some aircraft it is possible to change settings in flight. The setting range is from 25 to 125 feet.

The desired effect of a depth bomb is to create a pressure wave against underwater targets, and a concussion great enough to crush the hull plates of the target is the result. Depth bombs may be fitted with both a nose impact fuze and a tail hydrostatic fuze, but both should be used only when the aircraft has selective arming so that either fuze may be armed as desired. In this manner, advantage may be taken of the discovery of a surface target by arming the nose impact fuze. By leaving the nose fuze safe and only the hydrostatic tail fuze armed, an attack against a submerged submarine may be made.

The nose fuze generally used is the AN–M103A1, and the only hydrostatic fuze used is the AN–Mk 230 and Mods. When a nose fuze is used, it must be set on "instantaneous" as any delay would allow the very light bomb casing to rupture before detonation could take place, and a special arming vane must be used. The blast effect from a depth bomb is

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slightly greater than that from a GP bomb of the same weight due to the higher loading factor.

Depth bombs are cylindrical and have flat noses to prevent ricochetting when released at low altitudes and high speed. The flat nose explains why a special arming vane must be installed on the nose fuze.

Impact with the water from high altitudes can crush or warp the bomb body and distort the fuze cavities, causing a malfunction. As a result, depth bombs must be released from comparatively low altitudes.

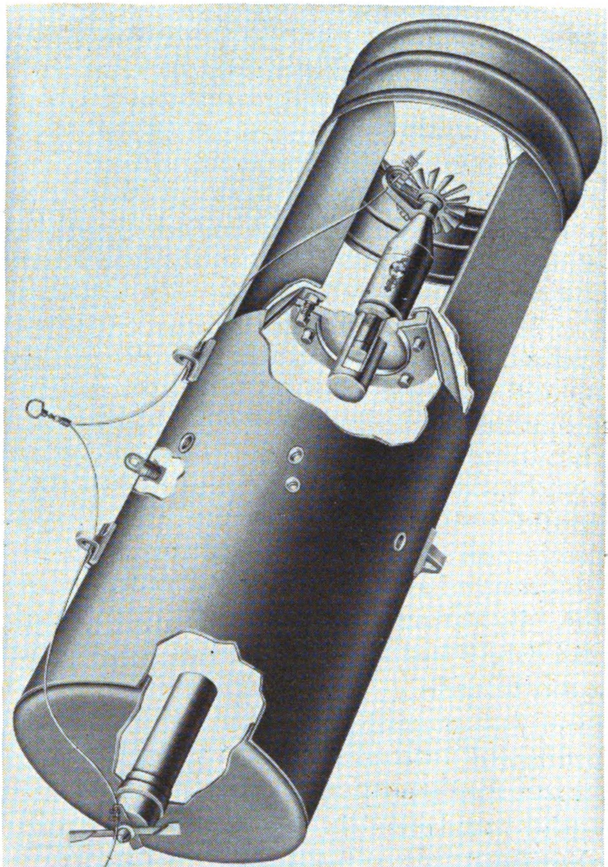

Figure 3–5.—350-pound Depth Bomb AN–Mk 54 Mod 1.

Depth bombs are painted olive drab with yellow nose and tail stripes. Markings on bombs having HBX–1 fillers are red, while older bombs with Torpex fillers have blue markings.

350-POUND DEPTH BOMB AN–MK 54 MOD 1 is made of thin sheet metal, is flat-nosed, and has fuze cavities fore and aft. Pellet-type auxiliary boosters are used in both fuze seat liners. The bomb is 52.5 inches in overall length, has a body 13.5 inches in diameter, and is filled with 248 pounds of HBX–1. It has a ring type tail which is bolted on, and double and single suspension lugs, also bolted on. Each bomb is shipped with two screw-in hoisting lugs, and the body has seven tapped holes about the circumference. By positioning the lugs in the necessary hole or holes, any hoisting condition can be met.

FRAGMENTATION BOMBS

Fragmentation bombs cause destruction primarily by the bursting of their cases. The cases of these bombs are so constructed that, upon detonation, they break up into hundreds of fragments which will destroy personnel, animals, and light material targets such as motor transports and aircraft on the ground. Fragmentation bombs are fuzed to explode before penetration.

A fragmentation bomb usually consists of a thin steel cylinder around which is wound a heavy helical steel band. When the filler explodes, this coil of steel splinters.

Fragmentation bombs range in size from 4 to 260 pounds and bigger ones are being developed. Smaller bombs are usually dropped in clusters of 3, 6, or more. The CLUSTER is formed by securing the bombs in a framework, usually made of tubing and sheet metal, called a CLUSTER ADAPTER. As the cluster is released from the plane, the bombs separate and cover a wide impact area. The releasing device of most clusters used by the Navy is entirely mechanical. Clusters are generally shipped assembled as complete rounds, with individual bomb fuzes already installed, although some newer types have fuzes packed with the cluster and not installed. The nomenclature used with clusters is more detailed than with other types of munitions; the cluster adapter itself may have one AN designation, and when loaded with bombs, the resulting cluster will have a different AN designation. A complete nomenclature gives the WEIGHT CLASS OF THE CLUSTER, the TYPE OF CLUSTER ADAPTER, the NUMBER, WEIGHT, and TYPE OF BOMBS CONTAINED, and, in some cases, the TYPE OF FUZES installed in the bombs. A typical example would be: 100-pound Cluster AN–M1A2 with Cluster Adapter AN–M1A3 and six 20-pound Fragmentation Bombs AN–M41A1 with Fuzes AN–M158.

Fragmentation bombs are stabilized with either tail fins for high-level use or a parachute for low-level attacks. As the parachute-type bombs leave the cluster, the parachutes open and the bombs descend slowly. These bombs can be dropped from altitudes as low as 70 feet; without parachutes at this low altitude the launching plane would be directly overhead as the bombs exploded and the fragments might destroy the aircraft.

All fragmentation bombs 120 pounds and larger are both nose and tail fuzed; those smaller are nose fuzed only.

Fragmentation bombs are painted olive drab. Large bombs have yellow nose and tail stripes while small ones have nose and tail painted yellow. Markings are in black.

4-Pound Fragmentation Bomb AN–M83

This is the only bomb of this type used today, and is a development of a similar German bomb used with considerable success, especially in the North African Campaign of World War II. It is the only fragmentation bomb used which has a TNT filler and has no helical steel outer band. The bomb is cylindrical, with a cast steel body containing approximately ½ pound of TNT. The fuze is set into the body, and has a cable extension on which the bomb case assembly (butterfly wings type) is mounted. When the bomb is released from the cluster, the butterfly wings open by spring action and, because of their construction, begin to rotate, arming the fuze and slowing the descent. This bomb is often referred to as the "butterfly bomb" because of its appearance while falling.

Fuzes used in these bombs are installed during manufacture and no attempt to remove them must be made. Three fuze designations are used, each with a different action, and each cluster usually contains bombs fuzed with all three types. Fuzes used are:

1. M129, which is set to detonate either in the air or upon impact with the ground. The aerial burst is not used by the Navy.
2. M130, a delay fuze, which is preset to detonate either 10, 20, 30, 40, 50, or 60 minutes after impact.
3. M131, an antidisturbance fuze. After initial impact with the ground, any attempt to move the bomb will result in immediate detonation.

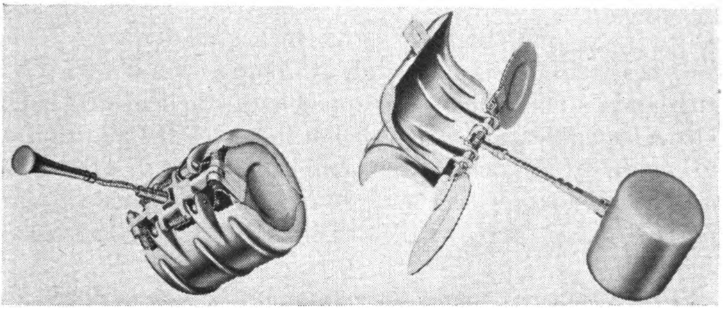

Figure 3–6.—4-pound Fragmentation Bomb AN–M83 (closed and open).

This bomb is always cluster loaded in one of two types of cluster. One is the 100-pound size Cluster AN–M28A2, which is the Cluster Adapter M15A2 loaded with 24 AN–M83 bombs. This cluster is already packed when received and requires only fuzing by the ordnanceman. Total weight of this cluster is approximately 119 pounds. The other cluster used is the 500-pound size Cluster AN–M29A1, which is the Cluster Adapter M16A1 loaded with 90 bombs. This cluster adapter is shipped empty, along with the bombs, which are packed in "wafers" of 10 each. These "wafers" are loaded into the cluster by the ordnanceman, taking care to follow the proper prescribed procedure. This cluster weighs 415 pounds complete, and both clusters have provisions for either double or single suspension.

The fuze used in these clusters is the Mechanical Time Fuze AN–M146 which contains a charge of black powder sufficient to open the cluster, and which has a variable delay of 5 to 92 seconds. When used with either of the clusters mentioned above, the delay used is 5 to 8 seconds. Due to the dispersal of the bombs, the maximum release altitude is 5,000 feet, with a fuze delay of 8 seconds, and minimum release altitude is 2,000 feet with a fuze delay of 5 seconds. The cluster will then open at approximately 1,500 feet.

20-Pound Fragmentation Bomb AN–M41A1

This is a high-level bomb stabilized by fins and generally carried six to a cluster. It is cylindrical, 22.3 inches long when fuzed, and the body is 3.6 inches in diameter. The filler is approximately 3 pounds of Composition B with TNT surrounds, and the body is wrapped with a helical steel band. The A1 modification of this bomb indicates the addition of a shoulder at the nose of the bomb to provide a bearing for the cluster adapter so the clustered bombs can be shipped unfuzed. Nose fuze AN–M158 or AN–M110A1 is used in this bomb.

Six AN–M41A1 bombs are carried in the 100-pound Fragmentation Bomb Cluster AN–M1A2. The older clusters used the Cluster Adapter AN–M1A2, in which the bombs were shipped fuzed, while later clusters use the AN–M1A3 Cluster Adapter which permits bombs to be fuzed just before use. Functioning of both types is the same.

The bombs are supported in the cluster adapter, and each three bombs are encircled by a steel strap which is secured at one end to the adapter. These straps hold the bombs securely in the adapter. When suspended from a bomb rack or shackle, the arming wire holds the strap clamps closed until the cluster is released armed. Upon release, the cluster falls away, the arming wire pulls out, the strap clamps open, releasing the straps, and the individual bombs fall free.

Until this moment, bomb fuze arming vanes are prevented from rotating by the vane stops in the cluster adapter. If the cluster is released unarmed, or "safe," the cluster retains the arming wire, and bomb fuze vanes are prevented from rotating and arming.

23-Pound Fragmentation Bomb AN–M40A1

This is a low-level bomb whose body is identical to that of the AN–M41A1 but which is stabilized by parachute. It is carried in clusters of three. While fragmentation, filler, and body specifications are identical to the AN–M41A1, the overall length of the fuzed bomb is 30.0 inches, the increase being due to the parachute and container. It weighs approximately 25 pounds complete. The fuze used with this bomb is the Nose Fuze AN–M120A1, which is armed by mechanical time action 1.9 seconds after the parachute opens. A1 designation indicates that a shoulder has been added to the bomb, as with AN–M41A1. (See fig. 3–7.)

The parachute is eight feet in diameter and is slit down one side to prevent oscillation or swinging as the bomb descends.

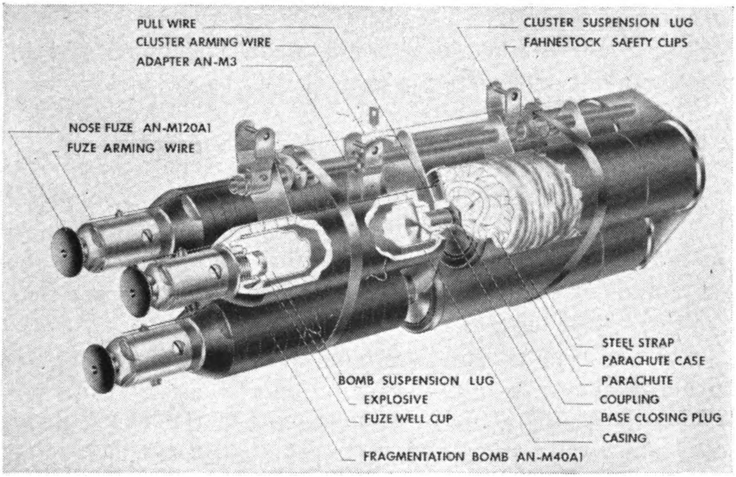

Figure 3–7.—Fragmentation Bomb Cluster AN–M4A1 with Fragmentation Bombs AN–M40A1.

The fuze arming wire is attached to the parachute in such a manner that, as the parachute opens, the arming wire will be withdrawn, allowing the fuze to arm.

These bombs are loaded into the Cluster Adapter AN–M3, which consists of two longitudinal steel tubes welded to five supports. Three suspension lugs are available for single or double use. Welded to the upper member are two mechanical release mechanisms which allow the two steel straps which hold the bomb to open. Three rests and five springs are attached to the lower member; the springs aid in ejecting the bombs from the cluster.

The complete cluster is designated 100-pound Fragmentation Bomb Cluster AN–M4A1, and may be fuzed just prior to use instead of shipped with fuzes installed. It weighs approximately 88 pounds. When released armed, the cluster arming wire pulls out of the releasing mechanisms, opening the steel straps. The springs in the adapter assist in separating the bombs from the cluster. The rear of the parachute container falls away, and a cardboard disk beneath it, which is attached to the parachute, acts as pilot chute and draws the parachute from the container. As the parachute opens, it draws the fuze arming wire out of the fuze, thus allowing it to arm.

The bombs strike the ground in a vertical attitude and fuze action is extremely rapid.

260-Pound Fragmentation Bomb AN–M81

This is a high-level fin-stabilized fragmentation bomb. It is 43.7 inches in overall length and weighs approximately 262 pounds. The body is 8.1 inches in diameter and has about 36 pounds of Composition B with TNT surrounds as a main charge. (See fig. 3–8.)

The box-type tail fins are held on by a locking ring, and either double or single suspension may be used. Both nose and tail fuzes are used: Nose Fuze AN–M103A1 (instantaneous) and Tail Fuze AN–M100A2 (non-delay). The tail fuze cavity has a small-type adapter booster installed. This bomb is never cluster loaded.

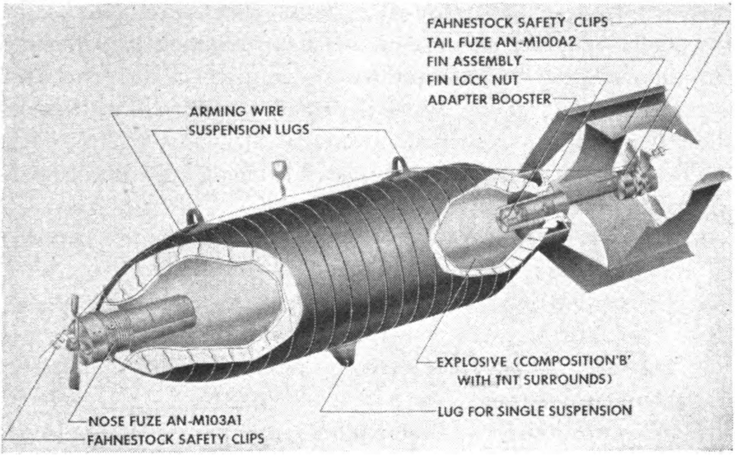

Figure 3–8.—Sectional view 260-pound Fragmentation Bomb AN–M81.

220-Pound Fragmentation Bomb AN–M88

This bomb is similar in construction to the AN–M81 and exactly like it in external dimensions. However, the AN–M88 is made up of ¾-inch bar steel wound around a ½-inch larger diameter internal steel case. The larger explosive cavity of the AN–M88 contains 41.4 pounds of Composition B with TNT surrounds. In this bomb, the ideal ratio of amount of explosive to size of outer steel band has been reached.

CHEMICAL BOMBS

Chemical bombs are classified according to filler as GAS, SMOKE, or INCENDIARY. Bombs filled with persistent or nonpersistent gas have not been used during hostilities but such bombs are available if needed. Smoke bombs have not had widespread use as they are employed only under special circumstances, such as marking a ground target. Incendiary bombs have been dropped in great numbers, and the ordnanceman will be called upon to handle large numbers of the various types when serving in a combat area. Small incendiary bombs are generally carried in clusters and large ones are dropped individually. Small incendiary bombs are extremely effective against cities when dropped in sufficient numbers. Over 28 million were dropped in Europe and more than 19 million were dropped on Japan in World War II.

The painting and markings code used to distinguish chemical bombs is given below:

1. Nonpersistent gas—body, blue-gray; bands, one green; markings, green.
2. Persistent gas—body, blue-gray; bands, two green; markings, green.
3. Irritant smoke—body, blue-gray; bands, one red; markings, red.
4. Screening smoke—body, blue-gray; bands, one yellow; markings, yellow.
5. Incendiary—body, olive drab; bands, one purple; markings, purple.

A brief description of the various types of chemical bombs follows.

SMOKE BOMBS

All-purpose Chemical Bomb AN–M47A2

This bomb, which resembles the 100-pound water-filled practice bomb, is made of $\frac{1}{16}$-inch sheet steel. It is 48.9 inches long and the body is 8.1 inches in diameter. A later modification, designated AN–M47A3, is identical except that the tail fins are 3 inches longer for increased flight stability. The total weight of the bomb will vary according to the filler used; this can be gas or oil gel (incendiary use), white phosphorus (smoke), hydrocyanic gas, mustard gas, or phosgene.

The body of this bomb alone weighs 26 pounds and is coated on the interior with oil. A full length burster well extends from nose to tail and on impact spreads the filler in a circular area around the point of impact. The burster charge may be either tetryl or black powder, depending on the filler used. Nose fuzing is used, with the AN–M159 fuze used for instantaneous ground burst, and AN–M146 fuze used for aerial burst.

When used as a smoke bomb, the AN–M47A2 is filled with either white phosphorus (WP) or plasticized white phosphorus (PWP). PWP is a mixture of white phosphorus and synthetic rubber in xylene, and has less tendency to pillar (form vertical columns) than has WP. On impact, the burster scatters the filler over a circular area 30 to 50 yards IN RADIUS, producing an effective white smoke screen for 1 to 2 minutes when WP is used and 3 to 5 minutes using PWP. When loaded with PWP the burster used is tetryl, and is 37.5 inches long by 0.75 inch in diameter. All other bursters used in this bomb are 37.5 inches by 1.0 inch.

The AN–M47A2 Chemical Bomb has box fins and may use either single or double suspension.

100-Pound Floating Smoke Bomb Mk 3 Mod 0

This bomb is used for its screening effect in amphibious assaults and consists of an aluminum nose casting which carries the smoke charge, a hollow wood float to provide buoyancy, and a box-fin tail assembly with drag plate. It is 48.5 inches long, 10.25 inches in diameter, weighs 102 pounds and contains 59 pounds of HC smoke mixture. Two movable suspension bands are provided and either single or double suspension may be used.

A water-impact Fuze Mk 3 Mod 1 is installed in the nose when shipped; if desired, an adapter can be installed on the fuze to permit functioning on land impact. The Mk 3 Mod 0 Smoke Bomb produces a dense white smoke for 6 to 10 minutes. It must be dropped from an altitude of not less than 500 feet. When dropped from 5,000 feet or over, water depth must not be less than 40 feet. Below 1,500 feet, water depth must be 10 feet or more. The fuze incorporates a delay of 18 seconds to enable the bomb to return to the surface before commencing to smoke.

50-Pound Floating Smoke Bombs Mk 1 Mod 1 and Mk 1 Mod 2

These bombs are similar to the Mk 3 Mod 0 in all respects except size. They are 38.3 inches in length, 8.85 inches in diameter, weigh 54 pounds and contain 28 pounds of HC smoke mixture. Fuzing and suspension is identical with the Mk 3 Mod 0. Mk 1 Mod 1 burns 3 to 5 minutes while Mk 1 Mod 2 burns 6 to 7.5 minutes.

10-Pound HC Smoke Bomb M77

The M77 consists of a steel HEXAGONAL case 2.9 inches across the flats and 19.5 inches long. It weighs 13 pounds and is filled with 9.5 pounds of HC smoke mixture. The bomb has no stabilizing device and therefore uses the "all-ways" type Tail Fuze M150 which will function regardless of angle of impact. It will produce smoke for 8 to 20 minutes, and is for use over land only.

Clusters of this bomb are shipped assembled, and the Fuze M150 is kept in safe position by an arming pin, which is held in place by the adjacent bomb in the cluster. When the cluster is released and the individual bombs fall free, the arming pin of each fuze jumps out.

Caution: ONCE THE ARMING PIN JUMPS OUT, THE FUZE IS ARMED AND ANY ATTEMPT TO REINSERT IT MAY CAUSE THE FUZE TO FIRE.

Smoke Bombs M77 are assembled in three types of clusters:

1. 100-POUND QUICK-OPENING CLUSTER E44 of 14 10-pound Smoke Bombs M77, which is very similar in operation to the fragmentation bomb clusters described earlier. This cluster uses the CLUSTER ADAPTER M4 and the complete cluster weighs 193 pounds.
2. 500-POUND AIMABLE CLUSTER E67 of 38 10-pound Smoke Bombs M77, which uses CLUSTER ADAPTER M23. Aimable clusters are designed for high-altitude precision bombing and are equipped with box-type tail fins and an aerial-burst delay fuze which opens the cluster a predetermined distance above the ground.
3. 500-POUND AIMABLE CLUSTER E62 of 38 10-pound Smoke Bombs M77, which uses CLUSTER ADAPTER E6R2.

WAR-GAS FILLED BOMBS

The three service types of gas-filled bombs, in addition to the all-purpose chemical bomb AN–M47A2, are the 115-pound M70, 500-pound AN–M78, and 1,000-pound AN–M79. Each of these bombs has a full length burster charge to split the bomb case and disperse the filler.

115-Pound Chemical Bomb M70

This bomb uses mustard (H) as a filler, although white phosphorus (WP) or gas gel can be used if desired. It is 48.7 inches in length, the body is 8.1 inches in diameter, the filler (mustard) weighs 57.1 pounds, and the complete bomb weighs 122.5 pounds. It resembles conventional bombs and has box fins. It is fuzed in the nose with either the M158 or the AN–M110A1 nose fuze. This bomb is painted blue-gray, with the two bands and markings in green.

500-Pound Chemical Bomb AN–M78

Closely resembling the 500-pound GP bomb, the AN–M78 is 59.25 inches long with a 14.0-inch diameter body. As supplied, it is filled with one of three types of gas: Phosgene (CG), hydrocyanic acid (AC), or cyanogen chloride (CK). Depending on the filler, total weight will vary from 383 to 488 pounds. A number of different nose fuzes are authorized for this bomb and aerial or ground bursts may be obtained. Tail fuzes used are AN–M101A1, AN–M101A2, or M161. An adapter booster is used.

1,000-Pound Chemical Bomb AN–M79

Like the AN–M78, this bomb is a modified GP bomb. It is 69.5 inches long, 18.6 inches through the body, and weight varies with the filler. The bomb as supplied is filled with hydrocyanic acid (AC) giving a total weight of 707 pounds, or phosgene (CG) giving a total weight of 926 pounds. An adapter booster is used and fuzing is the same as the AN–M78 except that AN–M102A1 or A2 are used in the tail.

INCENDIARY BOMBS

There are two general types of incendiary bombs: the small intense-heat bombs of magnesium; thermate, and similar materials which burn with such heat that they can cut through steel decks; and the oil-gel dispersal type, usually a larger bomb which explodes on contact and throws small sticky particles of burning material over a large area, starting many fires.

Small bombs of both types are always carried in clusters, while the larger oil gel bombs are carried on either single or double suspension racks or shackles.

4-Pound Incendiary Bomb AN–M50A2 and AN–M50XA2

This is an intensive-type incendiary bomb which is always carried in clusters holding from 34 to 128 bombs. It has a hexagonal body, is 21.3 inches in length, 2.9 inches across the flats, and weighs 3.7 pounds. The main charge consists of 1.25 pounds of magnesium alloy (the bomb body) and 0.63 pounds of thermate. The tail is a hollow hexagonal steel shell which is identical to the body in outward appearance, and the nose of the body is closed with an iron plug which makes the bomb nose-heavy to aid stability in flight.

A simple impact fuze is installed in the after end of the body and this fuze is held safe by a safety plunger which is depressed by the adjacent bomb in the cluster. When the cluster opens, the plunger jumps out and the fuze is armed. On impact, the fuze striker detonates the primer which ignites a first-fire mixture, which in turn ignites the thermate.

AN–M50XA2 is the same as AN–M50A2 described above except that the iron nose plug is replaced by a steel shell containing a delay element, a detonator, and a tetryl bursting charge. This bomb burns for about 1.5 minutes at which time the delay element is ignited. The burning delay element provides a delay ranging from a few seconds to several minutes and explodes the detonator which explodes the charge and projects fragments of the steel shell and particles

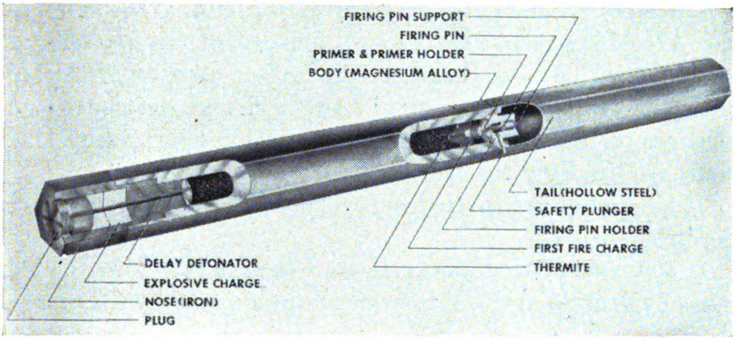

Figure 3–9.—4-pound Incendiary Bomb AN–M50XA2.

of burning magnesium. This antipersonnel effect discourages fire-fighting attempts following an attack. (See fig. 3–9.)

6-Pound Incendiary Bomb AN–M69 and AN–M69X

This is an oil-gel filled dispersal-type incendiary which is always carried in clusters. It has a hexagonal sheet steel body 19.5 inches long and 2.9 inches across the flats. The main charge is 2.8 pounds of gelled gasoline and an ejection-igniter charge of 0.4 ounce of black powder and magnesium. The total weight of the bomb is 6.0 pounds. The fuze used is Bomb Fuze M1, installed in the nose and impact-functioning with a 3- to 5-second delay to permit penetration. (See fig. 3–10.)

The case is closed at nose and tail by sheet steel cups. The nose cup contains the fuze, the ejection charge, and a diaphragm. The tail cup serves as an attachment and container for four 54-inch gauze streamers which stabilize the bomb in flight and reduce terminal velocity. The gel filler is contained in a cheesecloth sock, and on functioning is blown out the rear of the bomb.

The fuze is held safe by a safety plunger which is depressed by the adjacent bomb in the cluster; upon release from the cluster the plunger jumps out and the fuze is armed.

The 6-POUND INCENDIARY BOMB AN–M69X is the same as the AN–M69 except that a small amount of the gel filler is replaced with 4.5 ounces of tetryl. After ejection of the incendiary compound the tetryl burster charge detonates and shatters the case, creating a fragmentation effect which discourages fire-fighting operations.

These bombs are carried in five types of clusters which are described below:

1. 100-POUND INCENDIARY BOMB CLUSTER AN–M12, which uses CLUSTER ADAPTER M4 (same adapter as used with Smoke

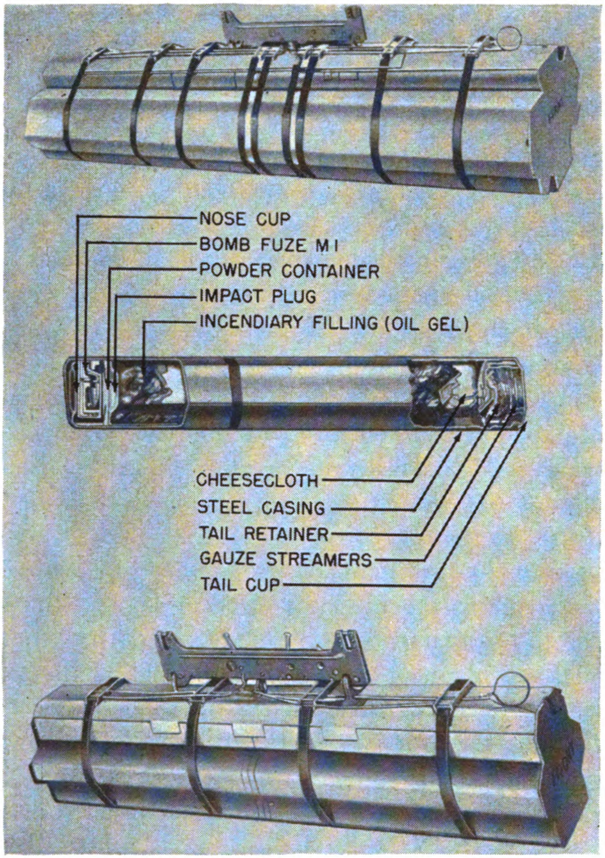

Figure 3–10.—6-pound Incendiary Bomb AN–M69, with clusters.

Bomb M77). It holds 14 bombs AN–M69. The bombs are held in place in the adapter by four steel straps, which are locked into their release buckles by a four-branch arming wire. On release, the arming wires pull out, the buckles release the straps, and the bombs fall free. Total weight of the cluster is 105 pounds.

2. 500-POUND AIMABLE INCENDIARY BOMB CLUSTER M19. This cluster, and the two following, use the same cluster adapters as the 10-pound Smoke Bomb M77 clusters described earlier, and are identical in operation. All three hold 38 bombs. The M19 cluster uses CLUSTER ADAPTER M23, filled with AN–M69 bombs.

3. 500-POUND AIMABLE INCENDIARY BOMB CLUSTER M21 also uses CLUSTER ADAPTER M23 but contains AN–M69X bombs.

4. 500-POUND AIMABLE INCENDIARY BOMB CLUSTER E28 uses CLUSTER ADAPTER E6R2 and contains AN–M69 bombs.

500-Pound Incendiary Bomb AN–M76

This is a modified 500-pound GP bomb assembly filled with 180 pounds of gasoline gel-magnesium incendiary mixture. The complete bomb weighs 475 pounds, is 59.2 inches in over-all length and has a 14-inch diameter body. A burster tube using tetrytol extends the length of the body and a white phosphorous igniter is used. A number of nose fuzes may be used, providing for either ground or air burst, and tail fuzes AN–M101A1, AN–M101A2, or M161 are authorized. An adapter booster is used.

NAPALM-FILLED FIRE BOMBS

Napalm-filled fire bombs were developed during World War II after considerable research and testing and have proven to be extremely effective not only as purely incendiary bombs, but against troop concentrations, wooden piers, wooden surface craft (singly and in concentrations), and inflammable stores. Napalm was formerly carried in modified aircraft droppable fuel tanks, but the need for fire bombs has led to the modification of practice bombs for napalm-gasoline filling. One type is teardrop shaped, another is cigar shaped. For maximum effect, fire bombs are released at low altitudes.

Napalm is an inert metallic soap (aluminum stearate) resembling sawdust in appearance and its sole function is to thicken or gel the gasoline to the proper consistency so that the fire has effective intensity, area coverage, and duration of burning. A mixture containing too little napalm gives a fireball effect and the duration is too short, while too much napalm results in ineffective coverage. The standard mixture now used in all napalm bombs is 94 percent by weight of gasoline and 6 percent napalm. Napalm is very hygroscopic and should not be used after absorbing any large amount of water. It is shipped in 60-pound drums, and has 6 to 7 percent anticaking agent added by weight. This anticaking agent is magnesium calcium carbonate in 50–50 proportions.

Fire bombs are provided with two suspension lugs, spaced 14 inches apart. The suspension lugs are attached to an inner support for additional strength.

Fire bombs are not sturdy enough to be lifted into place in the aircraft when they are full of napalm. The bomb is installed on the rack and then filled with the mixture. Once a bomb is filled it cannot be disassembled, it must be used or destroyed.

Detailed instructions for mixing the gasoline gel and filling the bomb are given in OP 1361.

Instructions for fuzing and arming are included in OP 1280.

PRACTICE BOMBS

Practice bombs, as the name indicates, are used to simulate the ballistic properties of service-type bombs for target practice. They are of two general types: the miniature practice bomb made of cast iron or lead antimony alloy, and the full-scale practice bomb made of sheet metal and filled with water or wet sand.

Practice bombs are painted black, with white markings. No bands are painted on the body.

Miniature practice bombs are made in 2 sizes and 3 weights, ranging from 3 to 13 pounds. All of them use a signal which fires on impact and enables the pilot to determine the exact striking point. The puff of white smoke created by the signal device is visible up to 14,000 feet in altitude. This signal, the AN–Mk 4, is discussed more thoroughly in chapter 7.

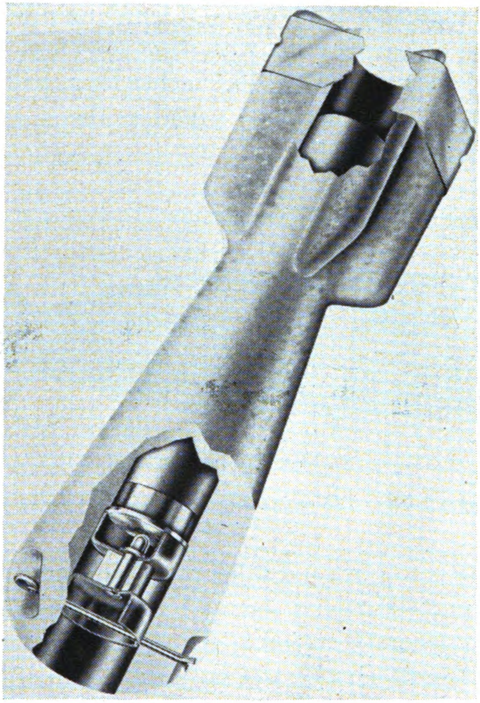

Figure 3–11.—3.0-pound Miniature Practice Bomb AN–Mk 23 Mod 1.

The AN–Mk 23 Mod 1 is a 3.0-pound miniature bomb, made of cast iron, and is 8.25 inches long by 2.2 inches in diameter. The complete round consists of the body, firing pin and cotter pin assembly, and AN–Mk 4 signal. It is used in a low-altitude and dive bombing practice, and MUST NOT be used against armored-deck target boats. (See fig. 3–11.)

The 4.5-POUND MINIATURE PRACTICE BOMB AN–MK 43 MOD 1 is the alternate bomb for the 3.0-pound miniature and is for use against armored-deck target boats. It has the same dimensions as the AN–Mk 23 Mod 1 but is made of lead antimony alloy. It should not be used for general practice as the supply is limited due to the material used.

The 13-POUND MINIATURE PRACTICE BOMB MK 19 and MODS is for high altitude horizontal bombing practice and is made of lead antimony alloy with sheet steel fins. It weighs 13 pounds, less the signal, is 13.1 inches long, and 2.6 inches in diameter. It uses the same signal as the smaller miniature practice bombs.

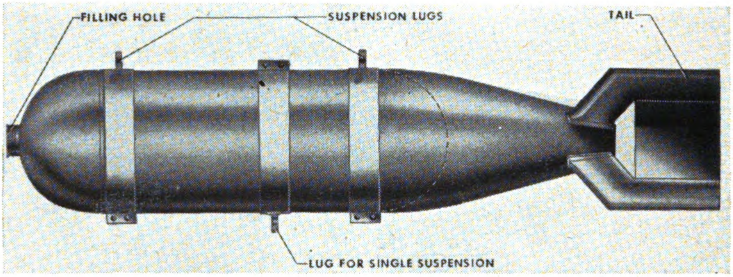

Figure 3–12.—100-pound Practice Bomb Mk 15 Mod 2.

The larger water or sand filled practice bombs range from 100-pound to 2,000-pound size and are constructed of sheet steel. They roughly resemble GP bombs and are shipped empty. When filled with wet sand they compare in weight with service bombs. They are relatively fragile and must be handled with care as the fins are easily bent, resulting in an erratic flight path. These bombs all have a filler cap at or near the nose. The 100-pound bomb has both double and single suspension lugs while the larger bombs have only double lugs. They may be used for all types of bombing practice, and signals may be used if desired.

Water and sand filled practice bombs are:

100-pound size, Mk 15
500-pound size, Mk 65
1,000-pound size, Mk 66
2,000-pound size, Mk 67

Drill Bombs

Drill bombs are used for the training of ground and flight crews in assembling, fuzing, unfuzing, and general handling of bombs, and for practice loading and unloading into and from aircraft. Drill bombs and their components are completely inert and usually consist of a standard bomb casing filled with plaster, cement, or other inert material, together with tail assembly and other parts comprising the complete round. Drill bombs weigh approximately the same as the corresponding service bomb and are painted olive drab with one nose band and one tail band in yellow. Markings are black, and include in large letters the words DRILL (INERT). Drill bombs are not expendable and may not be used as practice bombs.

SAFETY PRECAUTIONS FOR BOMBS

These safety precautions are general in scope; complete safety precautions pertaining to any particular type of ammunition or explosive may be found in the various publications dealing with the specific subject.

In handling munitions the ordnanceman must be 100 percent right every time; there are no half-way measures which are either safe or effective. The old saying "familiarity breeds contempt" is particularly applicable here, for if the ordnanceman in time comes to regard the munitions with which he works as just so much material to be loaded or unloaded, he is apt to overlook some of the ever-necessary precautions which MUST be observed. The great majority of service accidents in munitions can be traced directly to human error or carelessness.

Table 3–1.—Painting and Marking of Bombs.

Bomb	Body	Bands	Marking (letters and numbers)
High-explosive (GP, Demo., AP, SAP, Frag [1]) Filled with TNT, Explosive D, amatol or tritonal.	Olive drab	Nose: One 1″ yellow. Tail: One 1″ yellow.	Black.
Filled with Composition B.	Olive drab	Nose: One 1″ yellow. Tail: Two 1″ yellow.	Black COMP. B stenciled on one tail band.
Depth	Olive drab	Nose: One 1″ yellow. Tail: One 1″ yellow.	Torpex: Blue. HBX: Red. TNT: Yellow.
Practice	Black	None	White.
Drill	Olive drab	Nose: One 1″ yellow. Tail: One 1″ yellow.	Black DRILL (INERT).
Chemical		Nose, tail and center.	
Nonpersistent gas	Blue-gray	One green	Green.
Persistent gas	Blue-gray	Two green	Green.
Irritant smoke	Blue-gray	One red	Red.
Screening smoke	Blue-gray	One yellow	Yellow.
Incendiary	Olive drab	One purple	Purple.

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[1] Small fragmentation bombs: nose and tail painted yellow (no bands); olive drab.

The great hazard with bomb-type ammunition is not so much from instability or deterioration of the explosives, but from the enormous destructive effect of the accidental detonation of one round followed by instantaneous detonation of all rounds nearby.

Bombs must be handled with extreme care and must not be subjected to rough treatment in any handling operation. Thin case bombs, such as depth bombs, must be handled especially carefully to avoid dents in the casing.

Live loaded bombs must never be used to check the functioning of bomb racks, shackles, or other release mechanisms.

Bomb-type ammunition must be stored separately from other ammunition, and where possible, each type, such as torpedo warheads, depth bombs, mines and bombs, should be stowed by itself.

Munitions filled with TNT should be frequently inspected for exudation and, if exudate is present, it must be removed immediately by means of the authorized solvents.

Bombs should be stored in the metal crates or shipping bands in which they are shipped. Particular care must be taken that bombs do not become rusty or corroded, and if they do, the affected parts must be carefully cleaned and painted.

Aircraft smoke bombs and incendiary bombs are classified as pyrotechnics and must not be stored in magazines with explosive bombs. Auxiliary boosters, not assembled with detonators, may be stored in the same crates with bombs.

Practice and drill bombs must not be stored in the same magazine with explosive bombs.

Before installing fuzes in bombs, the fuze cavity threads shall be carefully inspected and wiped clean. Where pellet-type auxiliary boosters are required, a check should be made that boosters are installed in the correct number.

During assembly of bombs, all bolts must be used on bombs having bolt-on tail fins. When a fin locknut is used, it must be securely tightened.

Bomb clusters are more likely to be damaged by rough handling than individual bombs. They must be handled with more than ordinary care when they contain fuzed bombs. In this category are some small fragmentation bombs, all small incendiary bombs, and the Smoke Bomb M77.

Chemical bombs filled with poisonous gas are extremely dangerous to handle and special stowage and shipping procedures apply to all toxic-loaded bombs. HANDLING OR DISASSEMBLY SHOULD NOT BE ATTEMPTED except by authorized and competent personnel who are adequately protected by gas masks and special clothing and equipment where necessary.

Miniature practice bombs with signals installed are also extremely dangerous. In this condition these bombs are always armed and, if dropped, there is a good possibility of explosion. The resulting smoke and flame can burn personnel or damage aircraft, and in some cases the bomb body is shattered, resulting in serious injury. In installing the signals in the bombs, the signal MUST NOT be forced in place, and the loaders MUST NOT PLACE THEIR HEADS IN LINE WITH THE NOSE OR TAIL OF THE BOMB.

Arming wires must be free from kinks, burrs, dirt, and corrosion. They must be installed correctly in order to function properly on safe or armed drops and safety (Fahnestock) clips must be used in the correct number. Where an arming wire bracket is required, it must be correctly positioned on the fuze, the arming wire protective tube installed, and the bracket securely tightened to the fuze.

Suspension lugs should be examined for any damage which might weaken the lug or its attachment to the bomb body.

AIRCRAFT MINES

One of the first military applications of gunpowder was its use in setting off a stationary charge under the enemy before he knew he was in danger. This could be done by secretly digging beneath an enemy position and planting the charge, or by planting the charge where he was expected to go. The term MINE was applied to the charges because the technique was similar to that used in metallurgical mining.

Mines became really important in the Russo-Japanese War of 1904–05 when both sides used them liberally. The Russians not only pioneered in the development of the contact mine but specialized in minelaying as their principal naval technique. Mines were widely used in World War I, particularly in the defense of Great Britain.

During World War II aerial minelaying became one of the major offensive operations in the Pacific, and almost every type of bombing plane was used. Mines were used to block enemy harbors and sink enemy ships; defensive mines were laid to prevent enemy infiltration of harbors and sea lanes. In the course of the war 25,000 mines of all types were laid by the United States, of which 85 percent were aircraft mines. These aircraft mines sank 650,000 tons of shipping and damaged another 1,400,000 tons; the total tonnage sunk and damaged represents one quarter of the prewar strength of the Japanese merchant marine. It may be readily seen why minelaying is one of the principal missions of naval aviation.

In general, mines which fall within the cognizance of the Navy may be classified in three different ways: (1) by their position in the water, (2) by their types of firing mechanisms, and (3) by the type of launching craft used to plant them. Mines may be planted by SURFACE CRAFT, SUBMARINES, OR AIRCRAFT. This text is concerned only with AIRCRAFT MINES.

By their position in the water, mines fall into three classes: DRIFTING, MOORED, and GROUND mines. The DRIFTING MINE classification includes all types which are not attached to or resting on the bottom. They are so named because they float on the surface, or just below it; the latter type is kept in position by the action of a buoyancy chamber and a hydrostatic mechanism. This type is known as an OSCILLATING MINE because of its tendency to bob up and down in its attempt to maintain its set depth. Drifting mines have a contact-type firing mechanism, and are laid ahead of enemy ships, or in ocean currents or rivers where they will drift toward some focal point of enemy shipping.

MOORED MINES, as the name implies, have a positive buoyancy and are secured to an anchor. They are usually moored some distance below the surface, shallow enough to be detonated by a passing ship but deep enough to render visual detection difficult. Aircraft mines in the moored class are equipped with an influence-type firing mechanism, although those laid by other methods may have contact-type or shore-controlled firing devices.

GROUND MINES are laid in relatively shallow water where they sink to the bottom and lie there. For intercepting submarines they may be laid in deeper water. Because of its weight the ground mine does not need an anchor, and the firing mechanism is always of the influence type. The great majority of aircraft mines are ground mines.

By the type of firing mechanism used, mines again fall into three classes: CONTACT, CONTROLLED, AND INFLUENCE types. CONTACT types require that the ship actually come in contact with the mine or a float connected to it in order to detonate the charge. The type most likely to be encountered operates on the principle of the simple primary electric cell.

CONTROLLED MINES have their firing mechanisms operated electrically from a distance, and are used in harbor and shore defense mine fields. The operator simply fires the mine under the enemy ship and leaves the others intact. Aircraft mines are obviously never of this type.

INFLUENCE CONTROLLED firing mechanisms may be further broken down into MAGNETIC (*M*-type), ACOUSTIC (*A*-type), and PRESSURE types. Magnetic influence mines are of the DIP-NEEDLE OR INDUCTION type and are operated by the changes in the earth's magnetic field caused by the approach of a vessel, the needle type being best for use against slow ships while the induction type is best for use against fast ships.

The ACOUSTIC MINE is operated by an enclosed microphone which picks up the sound waves generated by the rotating screws or other machinery of nearby ships. A countermining device prevents detonation caused by the shock of explosions set off in attempts to sweep acoustic mines.

The PRESSURE MINE is detonated by a decrease in the pressure of the water surrounding it, which ordinarily is caused only by a large ship passing over it. The pressure type firing mechanism is used in conjunction with a magnetic-influence mechanism and this combination makes countermeasures almost impossible.

Most aircraft mines use parachutes to stabilize their flight and to decrease their impact velocity, thus allowing release from higher altitudes than those mines which have no parachutes. The parachute is opened by means of a static line which is attached to the aircraft. A release mechanism allows the parachute to separate from the mine upon impact with the water.

A CLOCK DELAY MECHANISM prevents firing until the mine has become submerged a preset time. Another clock is sometimes used to sterilize or dearm the mine after a selected period. A hydrostatically operated CLOCK STARTER starts the clock delay mechanism when subjected to sufficient pressure. The EXTENDER MECHANISM is a pressure-operated device which holds the detonator away from the booster until proper depth is reached.

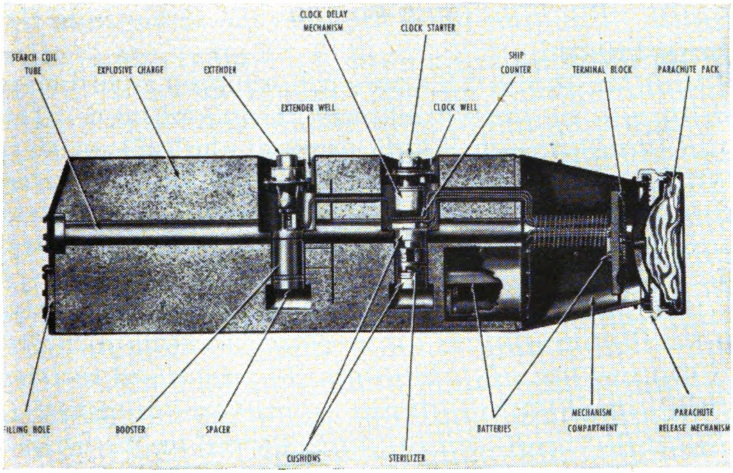


Figure 3–13.—Cutaway view of typical mine and accessories.

Soluble washers, or arming cells, may be used with clock starters and extenders to delay arming for periods ranging up to three days. When these devices are not used, most starters and extenders operate when a depth of 16 feet is reached.

Another delay device often used is the SHIP COUNTER which requires the near presence of a predetermined number of ships to actuate the mine firing circuit before the mine actually explodes.

The choice of proper combination of these features and delays is dependent upon planting conditions and is directed by the officer in charge of mining operations.

SERVICE AIRCRAFT MINES

The following brief descriptions of current service aircraft mines are general in nature. Complete descriptions and instructions will be found in the Ordnance Pamphlet or other publication dealing with the mine in question.

MINE MK 10 MOD 9 is a parachute-equipped moored mine. It uses a magnetic influence dip-needle firing device and contains 420 pounds of TNT. Total assembled weight is 1,800 pounds. This mine has a flat nose; the anchor is in the forward section.

MINE MK 13 MOD 6 is a parachute-equipped ground mine which uses an acoustic influence firing mechanism. The total assembled weight is 1,045 pounds of which 675 pounds is HBX–1. It is approximately 76 inches long, 20 inches through the body, and resembles a GP bomb. It has a round nose and 4 tail fins in addition to the parachute, which is 6 feet in diameter.

MINE MK 19 MOD 2 is a relatively small drifting mine of the oscillating type. It has no parachute, being stabilized in flight by fins only. It weighs 550 pounds and contains 190 pounds of HBX–1. It uses a contact type firing mechanism of the impact-inertia type. In appearance it resembles a depth bomb and has a flat nose, but smaller tail fins.

MINES MK 25 MODS 0, 1, and 2 are large parachute-equipped ground mines. They are alike in external appearance, differing mainly in types of firing mechanisms and total weights, and all contain 1,200 pounds of HBX–1. Overall length, including parachute pack, is approximately 87 inches and diameter is 22½ inches. The case is cylindrical with a tapered tail section and half the nose is flat while the other half slants aft. A 6-foot parachute is contained in a pack at the tail. Mk 25 Mod 0 mine uses a magnetic influence induction type firing mechanism and weighs 1,920 pounds. Mk 25 Mod 1 uses an acoustic influence firing mechanism and weighs 1,870 pounds. Mk 25 Mod 2 uses both magnetic induction and pressure type firing mechanisms and weighs 1,930 pounds. All three of the above may or may not have the cylindrical outline of the nose filled out with a thin metal fairing which is torn off when the mine strikes the water.

Mine Mk 26 Mod 1 is obsolescent and is mentioned here only because the remaining supply is classified for service. It is a parachute-equipped ground mine using a magnetic induction firing device. It is approximately 69 inches long, 18½ inches in diameter and weighs 1,060 pounds. The main charge is 520 pounds of Torpex. The nose is rounded and the 6-foot parachute is attached to the end of the tapered tail section.

Mines Mk 36 Mods 1, 2, and 3 are replacing the Mk 26 Mod 1. Mines Mk 36 Mods 1, 2, and 3 are alike in external appearance and differ mainly in firing mechanisms used and total weights. They are approximately 71 inches long and 18½ inches in diameter, cylindrical in shape with a tapered tail section and a half-straight, half-slanted nose. Like the Mk 25 mines, the cylindrical outline of the nose may be filled out with a thin metal fairing that is torn off when the mine strikes the water. All three modifications use a 6-foot parachute attached to the tail.

Mk 36 Mod 1 has a magnetic induction firing mechanism, is loaded with 600 pounds of HBX–1, and weighs 1,040 pounds. Mk 36 Mod 2 has an acoustic influence firing mechanism, weighs 1,020 pounds, and is loaded with 600 pounds of HBX–1. Mk 36 Mod 3 has both magnetic induction and pressure type firing mechanisms, weighs 1,065 pounds, and is loaded with 600 pounds of HBX–1.

Mine Mk 39 Mod 0 is a large ground mine using a magnetic induction firing mechanism. It does not have a parachute but is fin stabilized. The total weight is 1,990 pounds and it is filled with 925 pounds of HBX–1. This mine has a flat nose which is filled out to a semipoint with a plastic cover.

The tail fins are made of plywood and the case is heavy enough to withstand water impact despite the lack of a parachute.

SAFETY PRECAUTIONS FOR MINES

The handling of mines is a very specialized job and no unqualified personnel should ever attempt disassembly of mines or their components.

Many of the safety precautions which apply to bombs and which have been previously listed also apply to mines and must be observed where applicable.

Detonators must be handled with extreme care, especially when they contain fulminate of mercury.

Mines must be stowed in accordance with Ordnance Pamphlet 5—*Ammunition Ashore.* They are assembled by minemen or specially trained ordnance personnel according to the current Ordnance Pamphlet or other publication concerning the particular mine.

Detonators are stowed in a separate magazine and never with other types of munitions.

When a mine is jettisoned safe, the arming wires remain in the clock starter and booster extender, thereby preventing them from operating after the mine is submerged. However, the arming wires may be wiped off the mine when it strikes the water, hydrostatic pressure or countermining shock may shear the wires, or they may corrode and break after extended submergence. Therefore, **NO MINE CAN BE JETTISONED SAFE IN WATER LESS THAN 800 FEET DEEP WITH POSITIVE ASSURANCE THAT IT WILL NOT CONSTITUTE A HAZARD.** Depths greater than 800 feet will crush or flood the mine case, rendering the mine inoperative.

Such preflight handling of mines as is done by Aviation Ordnancemen will follow the same general handling techniques as for bombs or torpedoes of comparable size.

READYING AND LOADING OF MINES

A mine issued at a depot is assembled for service, except for battery, parachute, arming wires, detonator, hydrophone (if used), sterilizer, and soluble washers. At advance bases, mine assembly usually includes the installation of batteries and hydrophones.

A mine-warfare crew is responsible for the proper testing and installation of the sensitive influence mechanisms used in firing, and the mineman's preloading overall checks cover these and other operating components. In general, the Aviation Ordnanceman is not concerned with testing or installation of the above units, but is responsible for the following:

1. In some cases, proper installation of the electrically fired detonator in the extender mechanism.

2. Proper installation of arming wires in clock starter and extender. The arming plate or swivel loop of the arming wire is inserted in the arming-wire hook of the rack or shackle, or into the arming control used; the other end of the wire is run through the hole provided in the mechanism, and the correct number of Fahnestock clips are slipped on the wire and run up against the mechanism.

3. Proper installation of the parachute pack on the mine. The moisture-proof aluminum foil in which parachute pack containers are wrapped must not be broken or removed until the pack is installed. Care must be taken to protect the parachutes from moisture as they are severely weakened by wetting and may split under the impact of opening.

4. Proper installation of the mine in the rack or shackle, or in the bomb bay. This is done by regular bomb loading methods using the necessary hoist (or hoists) and hoisting band (or sling if used) except for assembling and securing the arming wires and the parachute static line.

Many mines have movable suspension and hoisting lugs which may be located to suspend the mine in the proper position. Others have more than one set of lugs secured to mounting pads which are welded to the case for the same reason. On the latter type, the unused lugs may foul the sway braces of a bomb rack or the shackle release units below the mine station in a bomb bay. In this case the unused lugs should be removed.

Suspension may be 14-inch or 30-inch, depending on the size of the mine, and some mines may use either. In many aircraft large mines are suspended on steel slings as are torpedoes and large bombs.

The parachute pack is secured to the mine in accordance with the instructions in the Ordnance Pamphlet or other publications dealing with the specific mine. After suspension, the static line which opens the parachute upon release is secured to the aircraft structure; most mine-carrying aircraft have a static line D-ring permanently installed for this purpose.

Arming wires may be installed either before or after mine installation, depending on rack or shackle construction and convenience in performing the operation.

QUIZ

1. Give the five classifications (according to use) of explosive bombs.
2. The loading factor of a bomb is the ratio of ---------- to ----------.
3. The loading factor of a GP bomb is approximately ---- percent.
4. The 2,000-pound General Purpose Bomb AN-M66A1 has suspension lugs spaced ---------- apart.
5. Where is a semi-armor-piercing bomb normally fuzed?
6. What basic color are the bodies of all explosive bombs painted?
7. Why do depth bombs have flat noses?
8. Low-level fragmentation bombs are stabilized by----------.
9. Chemical bombs are classified by filler as----------, ---------- or ----------.
10. According to their position in the water, the three classes of mines are ----------, ----------, and ----------.
11. The majority of aircraft mines are of the ---------- class.
12. Most aircraft mines use ---------- to stabilize their flight.
13. The clock starter and extender mechanisms are operated by ----------.
14. What are the three types of influence firing mechanisms used on aircraft mines?
15. Care must be taken to protect mine parachutes from ----------.

CHAPTER 4

BOMB FUZES

A fuze may be defined as a device for causing the detonation of an explosive charge at the proper time after certain conditions have been fulfilled. It is a mechanical device and should not be confused with another type used in explosives. This latter type FUSE is a slow burning cord intended to convey fire to an explosive charge slowly and without danger to the person lighting it. Fuses are mostly used commercially; a good example is a dynamite fuse.

This chapter deals only with AIRCRAFT BOMB FUZES; the other types of fuzes commonly encountered by the Aviation Ordnanceman—rocket and projectile fuzes—will be discussed in the chapters on rockets and gun ammunition.

Fuzes in general are classified by LOCATION, EFFECT ON EXPLOSIVE FILLER, and TYPE OF FUNCTIONING.

1. LOCATION

a. POINT OR NOSE fuzes are located at the forward end of the bomb, rocket head, or projectile. Used in projectiles, they are known as point fuzes, while in bombs or rocket heads they are called nose fuzes.

b. BASE OR TAIL fuzes are installed in the after end of the bomb, rocket head, or projectile. In projectiles and rocket heads they are referred to as base fuzes and in bombs as tail fuzes.

2. EFFECT ON EXPLOSIVE FILLER

a. DETONATING fuzes are designed to produce a shock effect for setting off high-explosive fillers. The great majority of fuzes used or handled by the ordnanceman are of this type.

b. IGNITION fuzes produce a flame for igniting explosives sensitive to flame, such as black powder. The fuzes used in some smoke and incendiary bombs are of this type.

3. TYPE OF FUNCTIONING

a. IMPACT fuzes function upon impact of the bomb, rocket, or projectile.

(1) INSTANTANEOUS OR NON-DELAY fuzes detonate immediately; they may be either nose or tail fuzes. Tail non-delay fuzes, due to their type of operation, are but slightly slower in functioning than nose instantaneous fuzes.

(2) DELAY fuzes detonate a predetermined time after impact. The delay is accomplished by means of a black powder or similar explosive train in SHORT-DELAY fuzes, and by means of chemicals or lead shear wires in LONG-DELAY bomb fuzes. Short-delay fuzes may be either nose or tail types, but those incorporating a long delay are always tail fuzes.

b. MECHANICAL TIME fuzes are often referred to as aerial burst fuzes and are so named because they have a clockwork mechanism which detonates the fuze after a preset time of fall. Earlier time fuzes used a slow-burning powder train but this type is no longer used by the Navy for bomb fuzes. The mechanical time bomb nose fuze will detonate on impact should it occur after the fuze has armed and before the clock has time to complete its operation.

c. HYDROSTATIC fuzes require water pressure to actuate the firing device, and also require a certain amount of air travel before the hydrostatic mechanism will function. They are used in depth bombs or in GP bombs when used against underwater targets.

d. PROXIMITY (or VT) fuzes contain miniature combination radio transmitters and receivers, and are always located in the nose. They detonate before impact when any substantial object is detected a predetermined distance away.

Bomb fuzes are designated by numbers; Army-designed fuzes are numbered from 100 to 199 while Navy-designed fuzes are numbered from 200 to 299. All Navy fuzes are safe for carrier landings and takeoffs; some Army-designed fuzes are not. Standardized fuzes which fit all AN standard bombs have the prefix AN. Like bombs, the letter M preceding the assigned number indicates an Army-designed fuze while Mk or Mark shows the fuze was developed by the Navy.

To be classified as carrier-safe, fuzes must meet certain qualifications. Nose fuzes must have a delayed arming time and usually a broken firing train in the unarmed condition. Tail fuzes must have only a delayed arming time although some also have a broken firing train. A fuze is ARMED when it is set to explode; when set NOT to explode it is said to be SAFE. When the pilot of an aircraft (or the flight crew ordnanceman, as the case may be) ARMS the bomb load, he sets the releasing devices or arming controls so that the fuzes will be free to function or arm as the bombs fall, thus permitting detonation at the proper moment. Different fuzes require different amounts of air travel before arming is completed; some fuzes arm very rapidly while others require a considerable fall.

The FUNCTIONING TIME of a fuze is the time it takes the fuze to detonate after impact. An INSTANTANEOUS fuze will detonate in 0.0003 second or less, a NON-DELAY fuze will detonate in 0.0003 to 0.0005 second, and a DELAY fuze takes more than 0.0005 second to detonate.

The firing train of an INSTANTANEOUS nose fuze consists of a STRIKER (or firing pin), DETONATOR, BOOSTER LEAD-IN, and BOOSTER. Note that the initiating device for a high explosive is usually called a DETONATOR; for a low explosive it is called a PRIMER. However, in some cases, the two words are used interchangeably.

The firing train of a DELAY nose fuze consists of a STRIKER, a PRIMER, a DELAY ELEMENT of low explosive which is ignited by the primer, a RELAY ELEMENT when needed to pass the flame from the delay element, a DETONATOR which is exploded by the flame from the delay element, a BOOSTER LEAD-IN, and the BOOSTER.

Nose fuzes and Navy tail fuzes contain a booster charge within the fuze body, while Army-designed tail fuzes contain only a primer detonator. The tail booster charge in Army-designed bombs is contained in the adapter booster discussed in chapter 3.

Both nose and tail fuzes have two general methods of arming: ARMING VANES and ARMING PINS. The ARMING VANE type requires air travel to turn the vanes, thus lining up the explosive train (in nose fuzes) and unlocking the striker or firing pin. The ARMING PIN type holds the striker locked (and a safety block in place in nose fuzes) until the bomb is released armed. As soon as the arming wire pulls out of the arming pin, the pin jumps out and the fuze is armed. The arming pin type is not carrier safe when a means of delaying the arming is not incorporated.

As already mentioned, Army-designed tail fuzes contain only a primer detonator, the booster being installed in the bomb. A PRIMER DETONATOR consists of a PRIMER, DELAY ELEMENT (except for non-delay action), and DETONATOR assembled into one interchangeable unit. A fuze may be equipped with any one of several optional delay or non-delay primer detonators.

Fuzes are identified by the information marked on the shipping container and stamped on the fuze body. They may be further identified by inspection. Army-developed rapid-arming tail fuzes, for example, are distinguished from slow-arming types by the rod which extends forward from the arming head along the arming stem for about 1.5 inches. Slow-arming fuzes have this rod (or CARRIER STOP PIN) while it is absent on the fast-arming type. Fuzes of one series—that is, those having the same mechanism and action but designed for bombs of different sizes—are distinguished among themselves by the length of the arming stem. Special-purpose fuzes, such as the hydrostatic, have a distinctive appearance and method of operation.

An ARMING WIRE is used to prevent the fuze from arming until the bomb is released. The arming wire is then retained by the shackle, rack, or arming control; the other end pulls out of the fuze permitting the arming device to function. Should the bomb be released safe, the arming wire will pull out of the suspension mechanism or arming control and fall with the fuze, thus preventing arming. Navy arming wires are made of 0.064-inch phosphor bronze wire, one end of which is secured loosely to a flat rectangular metal plate. This arming plate is cut out to receive the arming hook or solenoid plunger of the rack, shackle, or arming control.

Air Force arming wires are of the same diameter as Navy arming wires but are made of brass. In addition, a smaller diameter (0.036 inch) is used in some fuzes. Air Force arming wires do not have the arming plate but employ a swivel loop for the same purpose. Both Air Force and Navy arming wires use safety (Fahnestock) clips to hold the wire in the fuze and generally two clips are used. They should be run up snug against the fuze. As a general rule, from two to three inches of wire should extend beyond the fuze after installation, although instructions for some fuzes specify a greater amount.

The arming distance required for arming vane type fuzes is given in feet of air travel. This distance varies as to

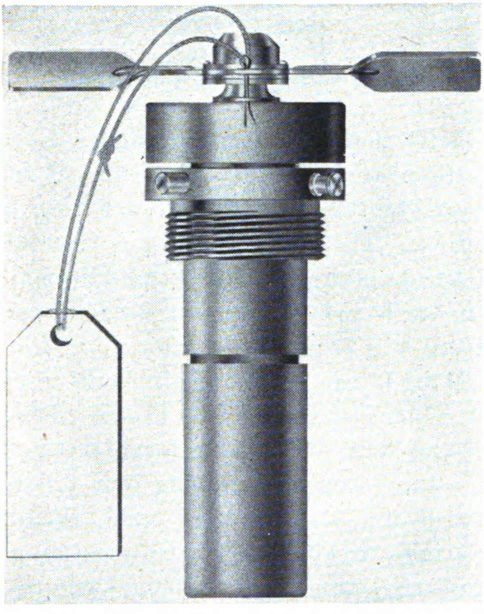


Figure 4–1.—Bomb Nose Fuze AN–M103.

speed of the releasing aircraft and size of the bomb. AIR TRAVEL refers to the distance traveled along the trajectory or arc described by the bomb as it falls from the releasing aircraft toward the surface and should not be confused with VERTICAL FALL. Vertical fall is defined at the VERTICAL DISTANCE between the point of release and the point where the fuze becomes fully armed, and will always be less than the air travel. When the arming distance in air travel is known, the vertical fall required can be computed for any combination of speed and dive angle by using the graphs available in certain publications dealing with fuzes, such as Ordnance Pamphlet 988—*Bomb Fuzes.*

There are many bomb fuzes classified for service use and it is beyond the scope of this text to describe or even list all of them. However, this chapter will give general data on most fuzes encountered by the Aviation Ordnanceman and will describe the operation of representative types most commonly used.

NOSE FUZES

Bomb Nose Fuze AN–M103A1

The AN–M103 nose fuze shown in figure 4–1 is a typical detonator-safe, arming vane-operated impact fuze. It has been superseded by the A1 modification, but the basic operation is the same. The only difference is that the later fuze designated A1 has been provided with additional safety features and hence is safe for carrier use. These additional safety features will be discussed later.

The AN–M103A1 can be used in all bombs of 100-pound or greater size which use a nose fuze except Chemical Bombs AN–M47A2 and M70. It has an external setting pin providing either instantaneous functioning or a 0.1-second delay. When installed in a 100-pound GP bomb, the air travel required for arming is 510 feet for delay action and 765 feet for instantaneous action. Larger bombs require greater air travel to arm.

The standard arming vane is 6 inches long, and has 2 blades with 60-degree pitch. If the standard vane is used on a fuze installed in a flat nose 350-pound depth bomb, the fuze will arm, but due to the ballistically poor shape of the depth bomb and the resulting disturbed air flow around the flat nose, 2,500 feet of air travel is required.

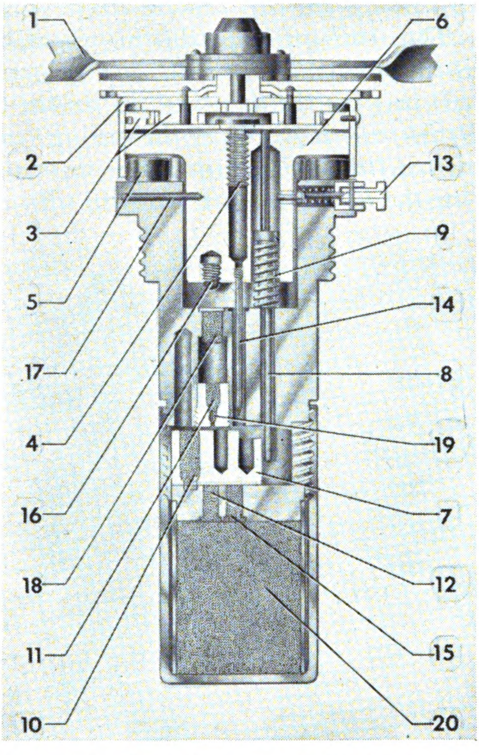


Figure 4–2.—Bomb Nose Fuze AN–M103 unarmed.

However, a special arming vane is available for use with flat nose depth bombs which is the same size as the standard vane but whose blades have a 30-degree pitch. One of these vanes is included with each 350-pound Depth Bomb Mk 54 and should be used on the nose fuze when installed. An AN–M103A1 nose fuze installed in a depth bomb and equipped with the special arming vane will arm in 1,800 feet of air travel.

Operation of the fuze is as follows (refer to figs. 4–2, 4–3, and 4–4):

The fuze contains four interrelated systems: arming, delay selecting, firing, and the explosive train.

The arming system consists of the arming vane (1), vane cup (2), reduction gears (3), arming screw (4), and safety disks (5). The arming vane, reduction gears, and arming screw are assembled in one unit with the vane cup; the safety disks are held between the flange of the striker (6) and the fuze body by the vane cup. When the arming vane is rotated by the air stream, the arming screw unscrews from the striker body carrying the vane gears and vane cup with it. Because

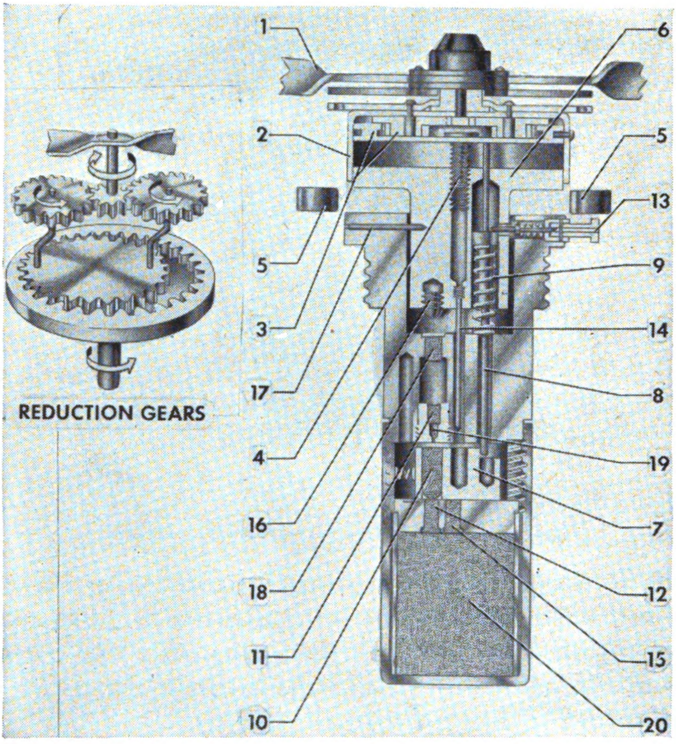


Figure 4–3.—Bomb Nose Fuze AN–M103 armed for delay action.

of the reduction gears, the vane turns 65⅓ revolutions to every complete turn of the arming screw. When the vane cup has progressed one-fourth inch the safety disks are released. Positive ejection is insured by a flat spring assembled within the circle of disks. The arming vane continues to rotate until the arming screw has progressed one-half inch. Then the entire assembly becomes disengaged from the fuze and falls free.

The delay selecting system consists of the detonator slider (7) which is held in place against spring action by the arming stem (8) which in turn is held in place by the arming assembly. As the arming screw advances, the arming stem follows, driven by its spring (9). When the stem has progressed one-fourth inch, it clears the first step of the detonator slider which moves to line up the detonator (10) with the delay element (11) and booster lead-in (12) of the explosive train. If the setting pin (13) is in the delay position, it restrains the arming stem from moving further (fig. 4–3), and on impact, the fuze functions with 0.1-second delay. If the pin is set for instantaneous action, the arming stem continues to progress until the stem clears the second step of the detonator slider and the slider moves to line up the detonator with the instantaneous firing pin (14) and booster lead-in (15). Upon impact, the fuze will function immediately.

The detonator is out of line with the other explosive elements until the fuze arms: the fuze is detonator safe.

Note: Once the fuze arms, the detonator slider cannot return to its original position.

The firing system consists of a cylindrical striker (6) and two firing pins, one for the delay train (16) and the other (14) for the instantaneous train. A flange at the outer end of the striker forms, with the fuze body, a groove which contains the safety blocks. The striker is held in place after arming by a brass shear pin (17) and the setting pin (13) which acts as an additional shear pin. Upon impact, after arming, the striker is driven inward shearing the pins and driving both firing pins with it.

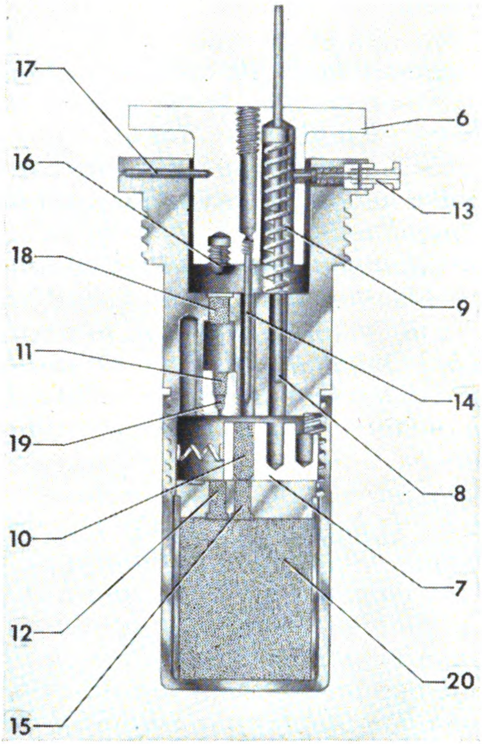


Figure 4–4.—Bomb Nose Fuze AN–M103 armed for instantaneous action.

The explosive train consists of a primer (18), delay element (11), relay charge (19), detonator, booster lead-ins, and booster (20). The primer, delay element, and relay charge are housed in the fuze body in position to be initiated by impact of the delay firing pin. The detonator is assembled in the detonator slider and the booster is assembled to the inner end of the fuze. When the slider is set for instantaneous action, the instantaneous firing pin is driven directly into the detonator—which serves as its own primer—and the primer, delay element, and relay charge, although they are fired by the delay firing pin, are bypassed, and the booster is detonated immediately.

The A1 modification eliminates the possibility of accidental detonation in crash landings and thus makes the fuze safe for carrier usage. In some cases during crash landings, the vane cup and head of the AN–M103 have sheared off, allowing the arming stem to jump out and the slider to align itself below the firing pin. On subsequent nose impact, the fuze has fired.

Operation of the AN–M103A1 is the same as that of the AN–M103 except that the arming stem in the A1, in addition to bearing against the internal gear, has its collar bearing against the larger and longer arming screw. In normal operation, as the arming screw moves out, the arming stem follows it, until the arming stem collar bears against the setting pin for delay action, or against the top of the cavity for instantaneous action. In a crash landing, if the vane cup and head shear off, the arming stem nevertheless is held by the arming screw which remains in place; hence the slider cannot move over and the fuze will not fire.

When used in Navy-designed bombs, such as the AN–Mk 54 depth bomb, a pellet type auxiliary booster must be used in the fuze cavity.

Caution: (1) If the delay arming assembly (vane, vane cup, and gears) is missing, or has unscrewed from the striker far enough to allow the safety disks to be ejected, the fuze is armed. (2) If the clearance between the vane cup and fuze body is greater than one-eighth inch, the fuze is **PARTIALLY ARMED.** Full instructions in the handling of armed and partially armed fuzes may be found in Ordnance Pamphlet 988—*Bomb Fuzes.*

Bomb Nose Fuze AN–M139A1

This fuze is the same as the AN–M103A1 except for the delay which is 0.01 second instead of 0.1 second.

Bomb Nose Fuze AN–140A1

This fuze also is identical to the AN–M103A1 except for a delay of 0.025 second.

Bomb Nose Fuzes M163, M164, and M165

These fuzes are identical to the AN–M103A1 except that they require a much longer air travel to arm and have different functioning times. They are intended for use in bombs dropped by large formations of planes from high altitudes. During World War II, instances occurred where bombs dropped from aircraft high in a formation struck a plane (and detonated) flying at a lower level in the formation. This series fuze is designed to prevent such accidents.

These fuzes require approximately 1,500 feet of air travel to arm for delay and 2,200 feet of air travel to arm for instantaneous action.

The M163 is identical to the AN–M103A1 in all respects including functioning time EXCEPT that it has the arming mechanism of the M103 (nonstandardized) fuze. This is a LONG ARMING DISTANCE mechanism. All three of these fuzes have the vane cup painted yellow to distinguish them from the AN–M103A1.

The M164 is the same as the M163 except that the delay is 0.01 second. The yellow vane cup has a 45° black segment painted on it to indicate this.

The M165 is also identical to the M136 except for a 0.025-second delay. The vane cup has a 90° black segment.

Bomb Nose Fuze AN–Mk 243 Mod 0

This is a water-discriminating vane-operated fuze used as an alternate to the AN–M103A1. It is designed to be used in conjunction with the Bomb Tail Fuze AN–M100A2 series fitted with a 0.24-second primer detonator against marine targets. If a direct hit is made against a surface target, the AN–Mk 243 (fig. 4–5) will function with a delay of 0.025 second; if a near miss occurs, the nose fuze will FAIL to function while the tail fuze will detonate the bomb beneath the surface for maximum mining effect. Hydrostatic tail fuzes set at 25 feet may be used but are not recommended.

The principle of operation is that an impact upon the striker must be sufficiently severe to shear three brass threads and allow the striker to impact the firing pin of the delay element. Drops from 20,000 feet onto water have resulted in no fuze action.

A reduction gear delay arming system is used and approximately 450 feet of air travel (130 vane revolutions) is required to arm. ***Caution:*** If the vane and vane cup are missing, or have separated from the vane cup support more than one-fourth inch, the fuze must be considered armed.

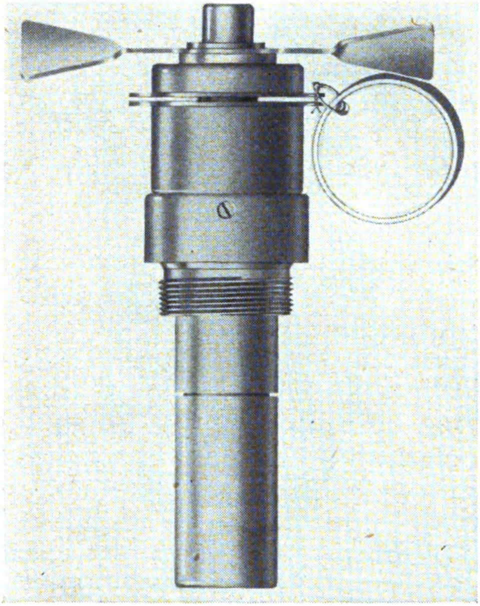


Figure 4–5.—Bomb Nose Fuze AN–Mk 243 (unarmed condition).

Bomb Nose Fuze (Mechanical Time) AN–M146

The AN–M146 fuze (fig. 4–6) is detonator-safe, combines vane and pin arming, and is time and impact functioning. The impact feature is for insurance only rather than for deliberate selection; it operates only when the time setting exceeds the time of fall. The AN–M146 may be set to function any time between 5 and 92 seconds after release. It has

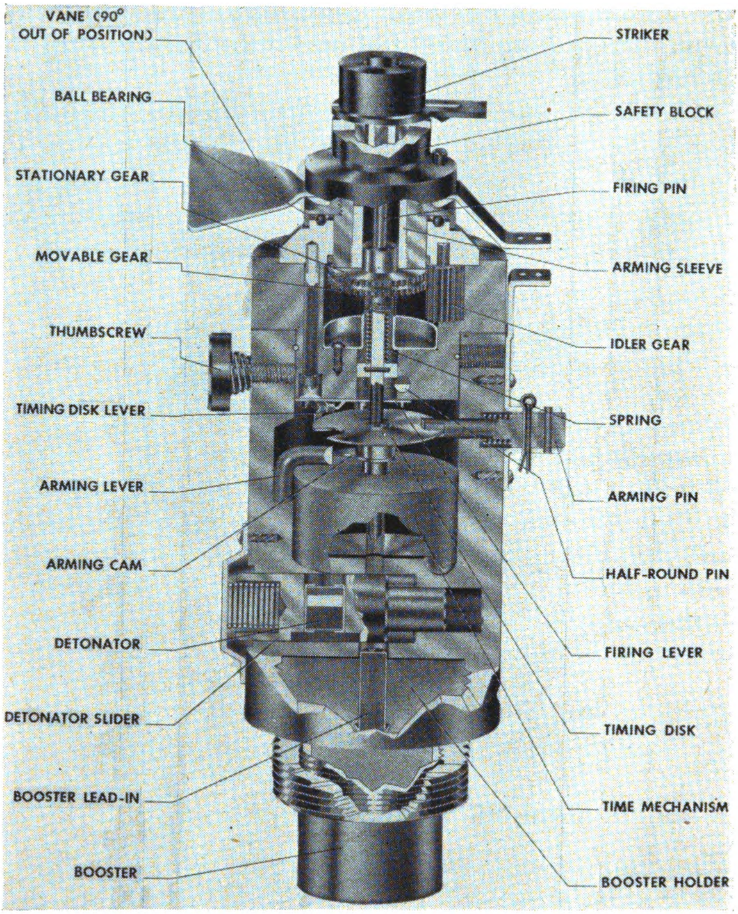


Figure 4–6.—Bomb Nose Fuze (mechanical time) AN–M146.

a black powder charge instead of a booster and can be used in the photoflash bomb AN–M46, "butterfly bomb" Clusters AN–M28A2 and AN–M29A1, and Chemical Bomb AN–M47A2 when a black powder burster is installed.

The fuse consists of a body, which contains the time element and explosive train, and a head, which contains the mechanical arming and firing system. The time settings are engraved around the base of the head in half-second increments numbered every three seconds, and an index mark for time setting is engraved in the body just below the head. A thumbscrew is provided to lock the head in position when the setting has been made.

MECHANICAL ARMING.—Refer to figure 4–6. The arming vane turns the arming hub assembly, to which the stationary gear is secured. The stationary gear drives the pinion or idler gear which, in turn, drives the movable gear secured to the arming sleeve. As the movable gear lags one tooth each revolution, it unscrews the arming sleeve from the hub, withdrawing the sleeve from the safety block. The C-shaped safety block is held between the striker and the vane nut, and has a collar which bears on pins in the vane nut. This forces the block to spin with the vane, and when the arming sleeve is fully withdrawn by the gear action, the safety block is thrown clear by centrifugal force. Mechanical arming requires approximately 1,000 feet of air travel.

The firing pin is now unlocked but is kept from striking the detonator by a shoulder on the firing pin which bears against a half-round pin. The half-round pin is held in place by the time mechanism until the preset time has elapsed.

TIME ARMING.—When the arming wire is withdrawn, the arming pin is ejected by its spring, freeing the timing disk and allowing the time mechanism to function, and the clockwork to turn the disk at a uniform rate. After 4½ ± 1½ seconds, the arming cam which is secured to the timing disk shaft has turned enough to release the arming lever. The arming lever unlocks the detonator slider which moves under spring action into the armed position where it is locked by a detent.

The timing disk continues to turn until a notch in its edge lines up with the timing disk lever. The timing disk lever then drops into the notch. This releases the firing lever which, in turn, releases the half-round pin. The firing pin is spring-loaded, and the spring pressure rotates the half-round pin a quarter turn so that the shoulder of the firing pin will clear it, thus allowing the firing pin to strike the detonator and initiate the explosive train.

The timing disk lever is set at the proper distance from the notch when the calibrated time ring is rotated to the desired time setting. If impact should occur before the set time expires, the firing pin will be driven in, shearing the trigger mechanism and firing the detonator. In the unarmed position, the notch in the timing disk is occupied by the arming pin (for clarity, the timing disk notch in figure 4–6 is shown out of position). ***Caution:*** (1) Fuzes which have less than one-eighth inch of the arming sleeve visible must be considered partially armed. The arming sleeve may be seen at the opening of the **C**-shaped safety block. (2) If the safety block is missing, the fuze must be considered armed. (3) If the arming pin is missing or partially ejected, the fuze must be considered armed. As little as one-tenth of an inch outward movement of the pin will let the time mechanism start. (4) If upon removing the striker stop, after threading the arming wire in place, the striker clamps down against the safety block, the fuze must be considered armed. This will occur if in some manner the firing pin has been unlocked or the trigger mechanism sheared by a blow against the striker and spring pressure is forcing it downward. If the trigger mechanism is intact, there will be a noticeable air gap between the striker and safety block.

When installing the fuze in a bomb, the arming wire must be run through the arming pin and bracket BEFORE the safety cotter pin is removed. Otherwise the arming pin will jump out as soon as the cotter pin is removed, allowing the time mechanism to function. If the safety cotter pin is found located in the outer holes of the arming pin bracket, the cotter pin should be examined to see that it is through the outer hole of the arming pin, because when the inner hole of the arming pin is opposite the outer holes of the bracket, the timing disk has been released.

Bomb Nose Fuze (mechanical time) AN–M145

The AN–M145 is essentially the same as the AN–M146 except that in place of the black powder charge it is fitted

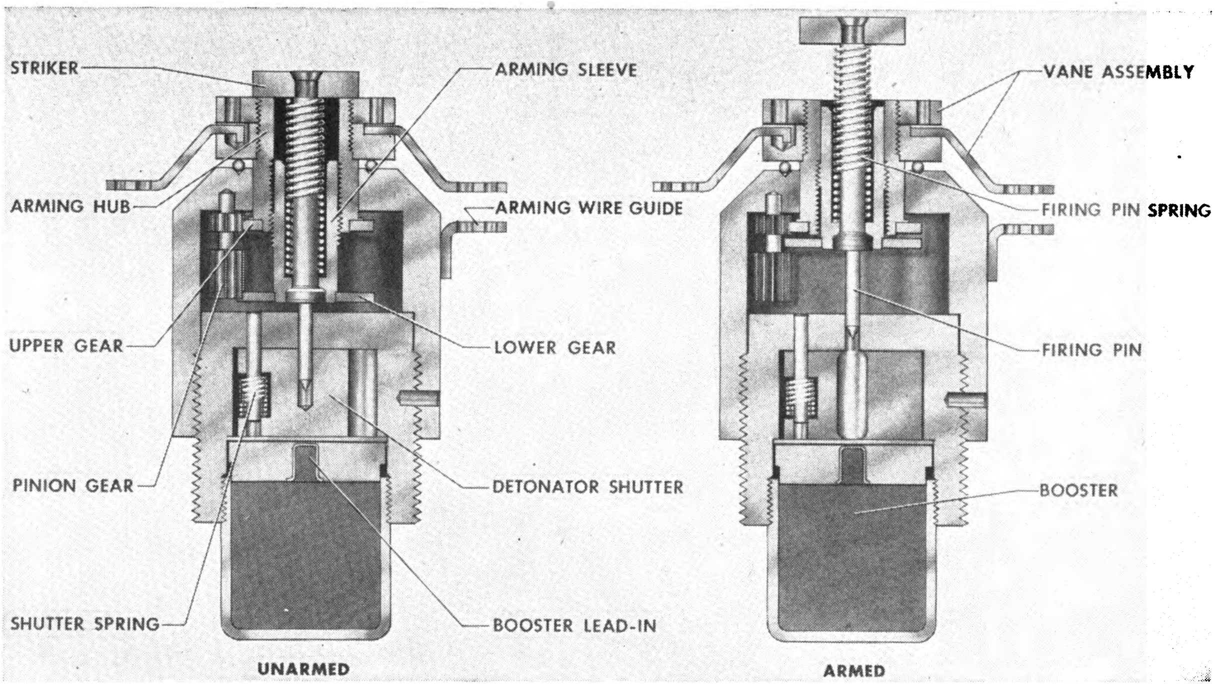


Figure 4–7.—Armed and unarmed views of the Bomb Nose Fuze AN–M158.

with a tetryl pellet and clay pellet booster. It is used in certain aimable incendiary bomb clusters.

Bomb Nose Fuze AN–M158

The AN–M158 is a detonator-safe fuze designed to replace the older AN–M110A1 nose fuze. It is an arming vane type, delay arming, impact fuze and is used in the 20-pound Fragmentation Bomb AN–M41A1 and the 115-pound Chemical Bomb M70. The AN–M158 requires about 1,000 feet of air travel to arm, functions instantaneously, and is safe for landings and takeoffs (including catapulting) anywhere, including the decks of carriers.

The principle of operation of the fuze is as follows: After the arming wire has been withdrawn, or the bomb freed from the cluster adapter, the windstream rotates the arming vanes and attached arming hub. The upper gear is attached to the arming hub and rotates with it. Both upper and lower gears mesh with the pinion gear. The lower gear has one more tooth than the upper gear; therefore, it lags behind the upper gear one tooth for each revolution of the vanes. This lagging causes the arming sleeve, to which the lower gear is attached, to thread up into the arming hub. The firing pin and striker move upward with the arming sleeve, freeing the detonator shutter after about 1,000 feet of air travel. The shutter is forced over by its spring, aligning the detonator with the firing pin and booster lead-in. The shutter is held in this armed position by a spring-loaded detent. The fuze is completely armed when the shutter moves into the armed position.

On impact the striker forces the firing pin against its spring and into the detonator. If dropped safe, the detonator remains out of line with the firing pin and booster lead-in, and even though the fuze is crushed on impact, the booster will not detonate. ***Caution:*** If the striker has risen more than one-fourth inch above the vane assembly, the fuze must be considered armed. IF THE VANES ON AN ARMED FUZE ARE TURNED COUNTERCLOCKWISE, THE FUZE MAY DETONATE.

Bomb Nose Fuze AN–M159

This fuze is a detonator-safe fuze for use in the 100-pound Chemical Bombs AN–M47 and modifications.

It is identical to the Bomb Nose Fuze AN–M158 except that the booster element has been replaced by a metal holder containing a column of tetryl.

Bomb Nose Fuze AN–M120A1

Bomb Nose Fuze AN–M120A1 is an arming pin type, detonator-safe, impact fuze. It arms by mechanical time action 1.9 seconds after the arming pin is ejected and detonates instantaneously upon impact. It is used in parachute type fragmentation bombs and is carrier safe.

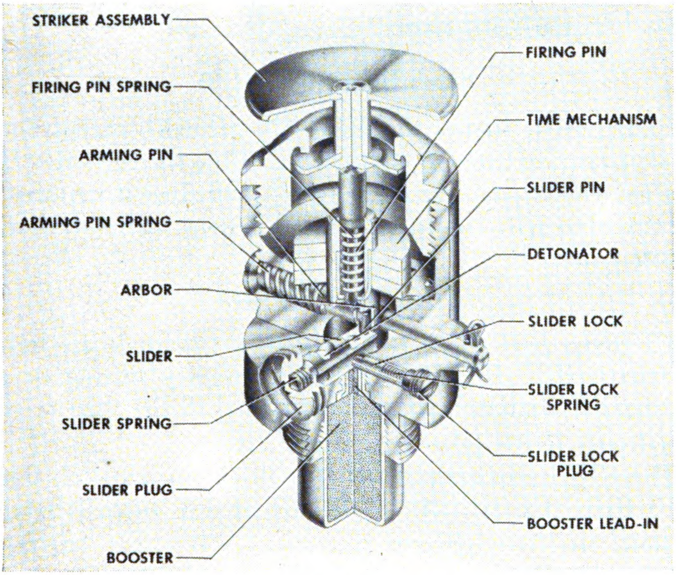


Figure 4–8.—Bomb Nose Fuze AN–M120A1.

In operation, the clockwork mechanism drives a hollow cylinder which contains the firing pin and is concentric with the axis of the fuze. A peg on the detonator slider bears against a cutaway section of this cylinder (the arbor) and holds the detonator slider in the safe position. A shoulder on the arming pin also bears against the arbor, preventing movement of the clockwork until the arming wire is withdrawn and the arming pin ejected. The arming pin extends completely through the fuze body and the pin also blocks the detonator slider until more than half of the pin is expelled. When the arming pin is ejected, the clockwork starts and rotates the arbor. After 1.9 seconds the arbor clears the peg and the detonator slider is moved by its spring so that the detonator lines up with the firing pin and booster lead-in. The detonator slide lock prevents any further movement of the slider. ONCE ARMED, THE FUZE WILL FUNCTION FROM A BLOW ON THE STRIKER IN ANY DIRECTION. ***Caution:*** When the arming pin is even partially ejected, the fuze should be regarded as EXTREMELY DANGEROUS and should be destroyed in place.

Bomb Nose Fuze M170

This fuze is identical to the AN–M120A1 except for a shorter arming time of 1.5 seconds. Like the AN–M120A1, it is extremely sensitive when armed, and since it requires no air travel to arm, bombs containing it must be handled with extreme care.

Proximity (VT) Fuzes

VT bomb nose fuzes are designed to produce air bursts automatically. In general, no preliminary setting or adjustment is required, since functioning of the fuze is governed only by its proximity to the target.

These VT fuzes are physically interchangeable with Bomb Nose Fuze AN–M103A1. The use of VT fuzes is advantageous in air-to-ground operation where air bursts at heights of 20 to 125 feet above the target increases bomb effectiveness, such as when attacking exposed troops, parked aircraft, vehicles, and similar targets. On the other hand, these fuzes would be worthless against a target which required the bomb to penetrate and explode within for effective destruction.

There are two basic types of VT fuzes: the RING TYPE, characterized by a heavy metal ring around the arming vane, and the BAR TYPE, which has two heavy metal bars extending like handles from the fuze nose, as shown in figure 4–9. Both types have an upper body about 3½ inches in diameter which extends forward from the bomb about 5 inches. The lower portion of the fuzes resembles that of the Bomb Nose Fuze AN–M103A1.

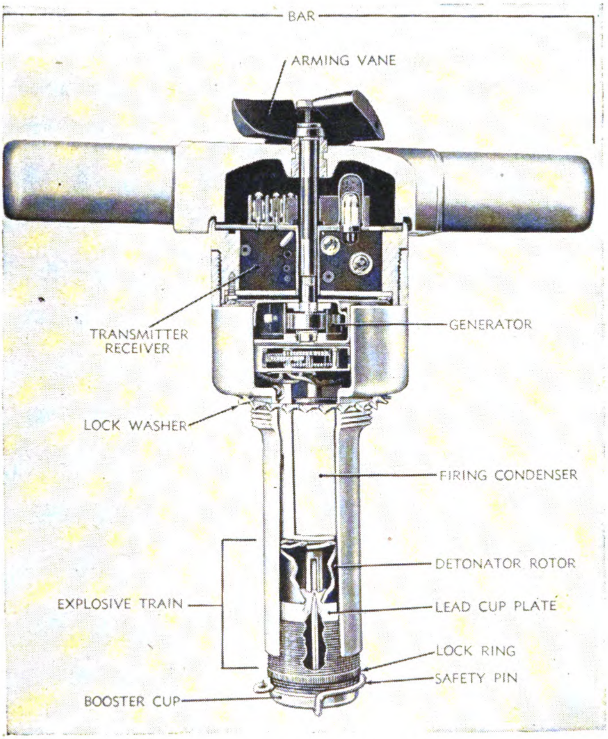


Figure 4–9.—VT Nose Fuze AN–M166—sectioned.

The height at which the fuze detonates depends upon a number of factors, including the nature of the target, the bomb-fuze combination employed, and target approach conditions (bomb striking angle and speed). Bar type fuzes generally burst slightly higher than ring type fuzes, and show less variation in burst height as bomb type is varied. Either type when released over average land will function in a majority of cases within 20 to 125 feet of the target. With both types, the average functioning height over sea water is about twice as great as over average land, while the functioning height over arid land, snow, or ice is lower.

As a very general statement, approximately 80 percent of VT-fuzed bombs released over average land will detonate between 40 to 75 feet from the ground.

The RING TYPE VT fuze generally has a plastic cone seated on the metal case of the upper fuze body. To this cone is attached the metal antenna ring and the 10-bladed metal arming vane which it surrounds. The arming vane is kept from rotating until armed release by a spring-loaded vane locking pin which may be positioned in any one of four holes spaced 90° apart in the antenna ring. Two wrench lugs are located 180° apart on the fuze body to permit the proper fuze wrench to be applied; unlike most fuzes, VT fuzes must be tightened with a wrench. A lockwasher is positioned between the bomb and the upper fuze body to insure a positive lock.

Ring type fuzes are most sensitive to passing targets, that is, objects abreast of the fuze rather than ahead of it. For this reason, ring type fuzes are affected by the angles at which they approach the target, these angles depending on the altitude, air speed, and approach angle of launching aircraft when the bomb is released.

BAR TYPE fuzes differ in appearance from the ring type in that the plastic nose portion is not conical and the antenna consists of two handle-like bars. The arming vane has three blades, is made of plastic, and is kept from rotating by a spring-loaded vane locking arm which is held in place by the arming wire. Bar type fuzes also have the two wrench lugs and lockwasher mentioned previously.

The sensitivity range of the bar type fuze extends ahead of it and the fuze is most strongly affected by a target directly in its path rather than to the side.

OPERATION.—The operation of both types is the same. On armed release, the arming wire is pulled out of the vane locking pin or arm, allowing the spring-loaded pin or arm to jump clear and free the vane. The vane begins to rotate in the windstream and through a gear reduction system turns the detonator rotor into the armed position so that firing the detonator will set off the booster. Movement of the rotor into the armed position also completes electrical connections between the detonator and the electronic firing head. The rotation of the arming vane drives a generator which supplies power to operate the firing head and charge the firing capacitor. Upon approach to the target, the radio signals sent out by the firing head are reflected by the target and are picked up by the firing head receiver, which, at the proper time, causes an electronic switch to close and fire the detonator.

The vane must turn a minimum of 1,000 revolutions to complete arming. Even after becoming fully armed the electrical firing circuit cannot function unless the arming vane is rotating at a speed equal to that which would be induced by an air speed of 80 knots or more. Further, the detonator is not electrically connected to the firing circuit until the rotor is in the fully armed position. The detonator is separated from the booster by a heavy brass plate until the detonator is aligned into the armed position. In most models a safety pin holds the arming assembly in the safe position until the pin is withdrawn when assembling the fuze to a bomb.

The SAFE AIR TRAVEL (SAT) is the distance a bomb must travel along its trajectory before the fuze can function. Due to manufacturers' tolerances and other factors, the SAT of supposedly identical fuzes may vary considerably. Because of this, each lot of fuzes is tested in the 100-pound GP Bomb AN–M30A1 to determine the MINIMUM SAT (MIN. SAT) of the entire lot. The MIN. SAT (the least air travel required to arm any fuze in the lot when used with the 100-pound GP bomb) is marked on each fuze. However, on larger bombs, the minimum air travel required for arming will be greater than the MIN. SAT marked on the fuze, by percentages ranging from 2 percent up to 58 percent, depending upon the size of the bomb.

The MIN. SAT of most fuzes is either 2,000 or 3,600 feet and is set by the manufacturer.

ARMING DELAY, AIR TRAVEL, M1A1 is an accessory device used to delay the start of the arming operation until a preset amount of air travel has been completed. The device is secured to the fuze so as to hold the vane locking pin or arm in place, and remains in place until the set amount of air travel is completed. The arming delay is vane driven with a gear reduction system. When the desired air travel is completed, the device frees itself from the fuze and falls away, allowing the vane locking pin or arm to eject itself and the fuze arming vane to commence normal rotation and arming. Thus the safe air travel of the fuze-arming delay combination is the sum of the arming delay setting and the MIN. SAT marked on the fuze.

Following are some special precautions and instructions in the handling of VT fuzes:

1. VT fuzes are shipped in sealed containers and should not be removed until just prior to use, since warm, humid weather in particular causes fairly rapid deterioration.

2. Make sure bomb tail fins are tight, as vibration of the fins may cause premature fuze action. For the same reason, the fuze must have a lockwasher between the fuze and the bomb, and the fuze must be tightened with a wrench. Do NOT attempt to use the antenna of bar type fuzes as handles for tightening.

3. The safety pin, located in a groove in the booster cup, must be removed prior to installing the fuze in a bomb. If the fuze is later removed from the bomb and returned to storage, the safety pin must be reinserted. If the pin will not go into place, it is an indication that the arming components are no longer in the safe position and the fuze must be destroyed according to current BuOrd instructions.

4. Under normal operating conditions, the spring pressure of the vane locking pin or arm is sufficient to hold the arming wire firmly in place during flight and no Fahnestock clip should be used.

However, if the arming wire will be exposed to the slipstream at speeds greater than 260 knots (300 miles per hour), additional precautions are necessary, because at these higher speeds it is possible for the force of the slipstream to pull the arming wire loop or arming plate out of the arming control mechanism. Then, as the wire whips in the slipstream, it works out of the vane locking pin or arm, the fuze arms, and is detonated by the aircraft carrying it.

On BAR TYPE FUZES ONLY, a second vane locking arm is installed, and the arming wire from this extra locking arm is secured to the aircraft structure. A Fahnestock clip is then placed on each wire, forward of (but adjacent to) the vane locking arm.

On RING TYPE FUZES, a second vane locking pin is installed, the arming wire of which is secured to the aircraft structure. Both arming wires are run through the holes in a perforated plate installed between the fuze and bomb, and a Fahnestock clip is placed on each wire between fuze and plate. In some cases, more than one clip must be installed on each arming wire.

TAIL FUZES

Bomb Tail Fuzes AN–M100A2, AN–M101A2, and AN–M102A2

These fuzes are vane-operated and function on impact. They are identical in every respect except length of the arming stem and arming stem tube, and consequently in overall length and weight. They are issued equipped with the M14 PRIMER DETONATOR 0.025-SECOND DELAY, but any of the following alternate delay M14 primer detonators can be readily installed: NON-DELAY, 0.01-SECOND, 0.10-SECOND, or 0.24-SECOND.

Bomb Fuze AN–M100A2 is used in 100-pound and 250-pound GP bombs and in 220-pound and 260-pound fragmentation bombs. It requires a maximum air travel of 485 feet to arm. This air travel is for the largest bomb in which used; air travel to arm will be less when used in smaller bombs.

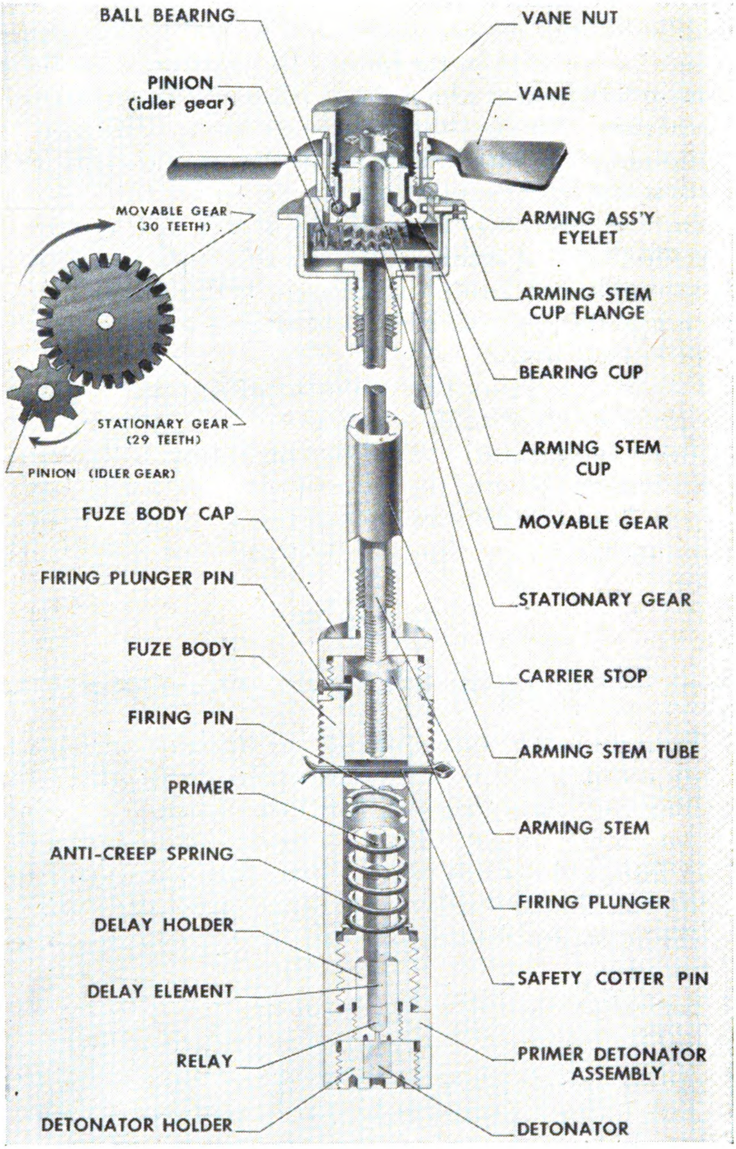


Figure 4–10.—Bomb Tail Fuze AN–M100A2 series.

Bomb Fuze AN–M101A2 is used in 500-pound GP, SAP, incendiary, and chemical bombs. It requires a maximum air travel to arm of 555 feet.

Bomb Fuze AN–M102A2 is used in 1,000-pound and 2,000-pound GP bombs and 1,000-pound SAP bombs. The maximum air travel to arm is 665 feet.

The variations in length are necessary to properly locate the arming vane in the air stream so that the same type fuze can be used in various sized bombs. These fuzes are safe for landings and takeoffs anywhere, including the decks of carriers.

Note that the arming stem is screwed through the fuze body cap before it is screwed into the firing plunger. This prevents a blow on the arming vane or gear mechanism being transmitted to the firing plunger. The end of the firing plunger pin rides in a groove in the firing plunger to prevent the plunger from rotating with the stem as the fuze is armed.

The principle of operation is as follows (refer to fig. 4–10) : When the bomb is released armed, the arming wire is withdrawn, allowing the air stream to turn the 4-bladed arming vane. The vane and bearing cup rotate together, and the pinion gear, meshed with both stationary and movable gears, moves around these gears. The stationary gear is kept from rotating by the carrier stop and has one less tooth than the movable gear, so that the pinion "walks" the movable gear around one tooth each time the pinion circles. Since the movable gear is secured to the arming stem, as the movable gear is walked around, it unscrews the arming stem from the firing plunger. Thirty rotations of the arming vane results in one rotation of the arming stem, and after 150 to 170 vane rotations, the arming stem is unscrewed from the firing plunger and the fuze is armed. The plunger is restrained from striking the primer by an anticreep spring, until impact of the bomb. The arming vane continues to rotate and after approximately 200 more revolutions the arming stem has unscrewed from the fuze body cap and the entire arming assembly (arming vane, gear mechanism, and arming stem) is carried away from the bomb by the air stream.

On impact of the bomb, the firing plunger is carried forward by inertia, overcoming the anticreep spring and striking the primer. The very slight lag due to the inertia of the firing plunger is the reason NON-DELAY TAIL FUZES function slower than instantaneous nose fuzes, in which the force of impact drives the striker or firing pin directly into the detonator.

Caution: (1) If the arming assembly is missing, the fuze is armed. (2) If the arming assembly is in place, the fuze may still be armed; if the distance between the arming assembly eyelet and the arming stem cup flange is less than ½ inch, the fuze is partially armed. If the distance is between ½ and ¾ inch, arming is questionable and the fuze should be considered armed. If the distance is greater than ¾ inch, or when the carrier stop pin protrudes below the vane cup less than 1 inch, the fuze is armed.

Primer detonator M14 used with these fuzes and primer detonator M16 used in other fuzes ARE NOT interchangeable. They may be distinguished by the knurling around the base, the M14 having one wide knurled band while the M16 has two narrow knurled bands. To change primer detonators, the one installed in the fuze is unscrewed BY HAND and the primer detonator to be installed is inspected, then screwed down in the fuze handtight.

Primer detonators have the delay time (or "non-delay") stamped on their bottom face and in addition use a color code on the bottom face to indicate delay. This color marking is as follows:

Non-delay—entire surface painted white
0.01-second—30° segment of face painted black
0.025-second—90° segment of face painted black
0.10-second—entire surface painted black
0.24-second—entire surface painted green

Bomb Tail Fuzes AN–M100A2, AN–M101A2, and AN–M102A2 (A2 series) replaced the older fuzes AN–M100A1, AN–M101A1, and AN–M102A1 (A1 series). The A1 series was similar to the A2 series except for the greater amount of air travel required for arming (approximately 2,000 feet) and an 8-bladed arming vane.

Bomb Tail Fuzes M160, M161, and M162

The M160, M161, and M162 fuzes are the same as Bomb Tail Fuzes AN–M100A1, AN–M101A1, and AN–M102A1, respectively, except that they use the same arming vanes as the AN–M100A2 series (4-bladed). For identification, these fuzes have a yellow band at least three inches long painted on the arming stem tube. Instructions which govern the AN–M100A1 and A2 series also apply to the M160, M161, and M162.

These fuzes require an air travel of approximately 2,000 feet to arm. They are intended for use in bombs dropped by large formations of planes from high altitudes, and should be used in conjunction with nose fuzes M163, M164, and M165 which also have a long arming delay and are intended for the same purpose.

Bomb Tail Fuzes M115, M116, and M117

These are arming vane type, delay arming, impact fuzes designed for low-level masthead or "skip" bombing. Primer detonators M16A1 are used, giving a delay of 8 to 11 seconds for use against shore targets, or 4 to 5 seconds for use against ship targets. This delay is to enable the releasing aircraft to clear the target before detonation. These fuzes can be used in 500-pound and 1,000-pound SAP bombs, and 100-pound to 2,000-pound GP bombs.

The M115, M116, and M117 are similar in external appearance to the AN–M100A2, AN–M101A2, and AN–M102A2 and have the same respective arming stem tube lengths. They are carrier safe, and have the same required air travel to arm as the AN–M100A2 series: 485 feet maximum for M115, 555 feet for M116, and 665 feet for M117. This amount of air travel is required when the fuze is installed

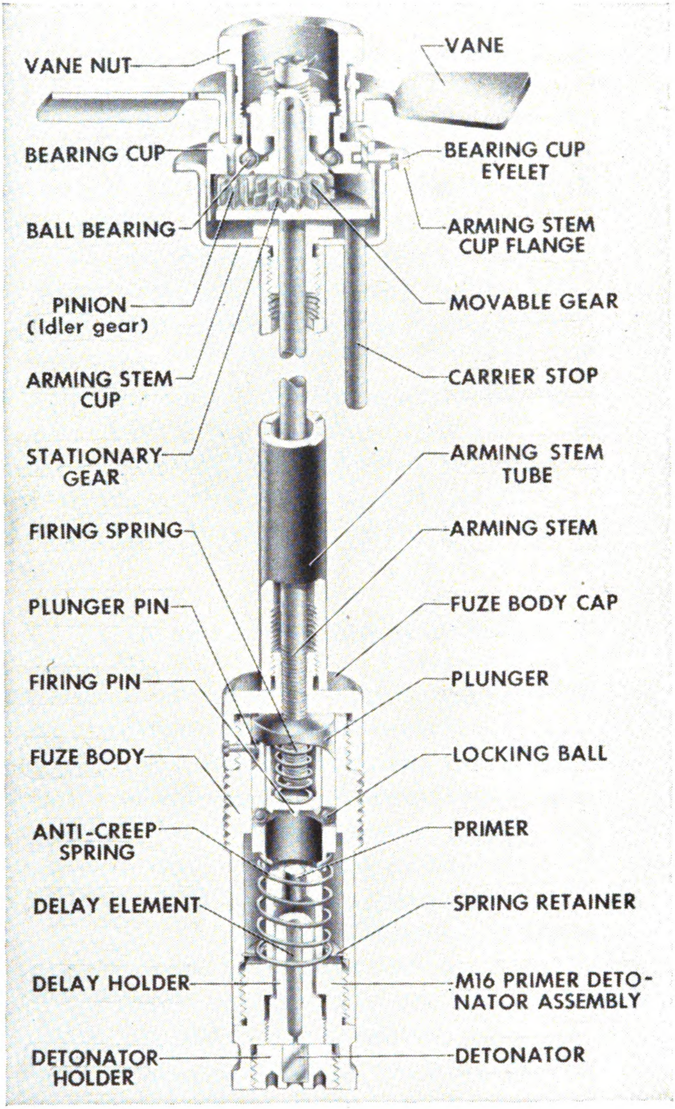


Figure 4–11.—Bomb Tail Fuzes M115, M116, and M117.

in the largest bomb in which used; when installed in smaller bombs the required air travel will be less.

The arming assembly (arming vane, gear mechanism, and arming stem) is identical to that used in the AN–M100A2 series fuze, and provides the same gear reduction. The firing mechanism, however, is different.

The firing mechanism (see fig. 4–11) consists of a firing pin and cocked firing pin spring, plunger, locking balls, anticreep spring, and retainer. The firing pin and spring are assembled inside the plunger with the firing pin spring in a compressed position behind the firing pin. They are held in this position by two locking balls in the plunger which are kept in place by the inside surface of the fuze body.

When the bomb is released armed, the arming stem unscrews from the plunger and fuze body cap in the same manner described for the AN–M100A2. The anticreep keeps the plunger assembly from moving forward until impact, when it is overcome by the inertia of the plunger. After moving a short distance forward, the locking balls pass a step on the inner surface of the fuze body and the balls jump out, thereby unlocking the firing pin. The compressed firing pin spring then drives the firing pin forward against the primer, which explodes and sets off the delay. After burning through, the delay sets off the relay which fires the detonator, the booster, and the bomb.

The fuze is SUPERSENSITIVE. The anticreep spring is just strong enough to balance the weight of the plunger assembly and only slight retardation of the bomb is necessary to initiate fuze action. With the fuze armed, impact with water or any light structure will result in fuze action.

The delay time of the M16A1 primer detonator is stamped on the end, and primer detonators are installed in the same manner as M14 primer detonators are installed in AN–M100A2 series fuzes. Do NOT attempt to interchange M14 primer detonators with M16A1 primer detonators; the threads are different and damage will result. M16A1 primer detonators may be distinguished by the double knurled band around the base. As issued, the fuze has the 4 to 5 second delay primer detonator installed. External indications of arming of these fuzes are the same as those listed for the AN–M100A2 series.

Bomb Tail Long-Delay Fuzes AN–M123A1, AN–M124A1, and AN–M125A1

These are vane-operated, quick-arming impact fuzes which contain a chemical long-delay device which will cause detonation from 1 to 144 hours after impact. They also have an ANTIWITHDRAWAL feature which will detonate the bomb instantaneously if an attempt is made to remove the fuze once it has been installed. The AN–M123A1 series differs from the obsolete M123 series in that the later AN type has NO reduction gearing and uses an 8-bladed arming vane rather than 4-bladed.

All three fuze types in this series will arm in less than 100 feet of air travel, including the sealing of the fuze body to prevent loss of solvent. They are carrier safe but bombs in which they are installed must either be dropped on the target or jettisoned—THEY ARE NOT TO BE RETURNED TO AIRFIELDS OR CARRIERS.

Fuze AN–M123A1 may be used in GP bombs up to 250 pounds. AN–M124A1 is used in 500-pound GP and SAP bombs. AN–M125A1 is used in 1,000-pound and larger GP and SAP bombs. The stem tube length is the only difference between fuzes of this series.

The fuzes should be used only in those bombs having adapter booster and base filler plug locking devices. Otherwise an enemy could easily disarm a bomb by simply removing the base plug or booster adapter with fuze still installed.

The delay times are determined by the strength of an alcohol-acetone solution which dissolves a celluloid collar. For the longer delays celluloid disks are added which must also be dissolved. These delays are installed by the manufacturer and may not be changed. Delays available are as follows: 1, 2, 6, 12, 24, 36, 72, and 144 hours. The nomenclature, model, delay, and other information is stamped on the fuze body below the threads, where it cannot be seen when

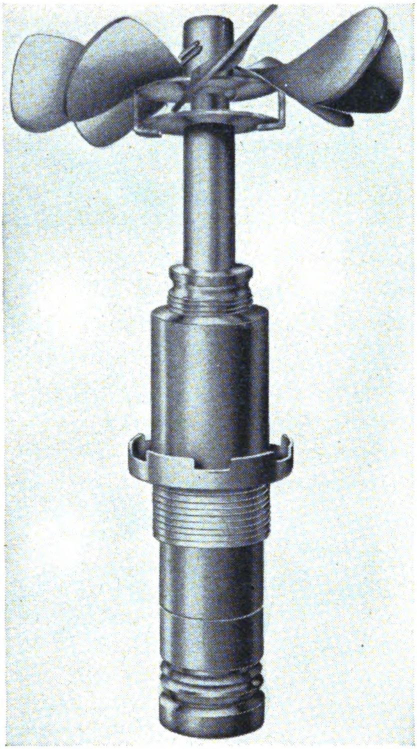


Figure 4–12.—Bomb Tail Long-Delay Fuze AN–M123A1.

installed. Any given delay time will be decreased by high temperatures and increased by low temperatures.

The arming vane is attached directly to the arming stem, and the stem in these fuzes screws INTO the body during armed release. The body assembly consists of the fuze body and the fuze body extension. The fuze body contains the FIRING PIN and SLEEVE ASSEMBLY, a DELAY WAD, and a GLASS AMPOULE FILLED WITH SOLVENT. The body extension contains the DETONATOR HOLDER screwed into the base, and a LOCKING BALL and GROOVE (antiwithdrawal device) in the side.

The firing pin (fig. 4–13) is held in place against the action of a compressed firing pin spring by the firing pin balls, which in turn are held in place under the firing pin screw by a cellu-

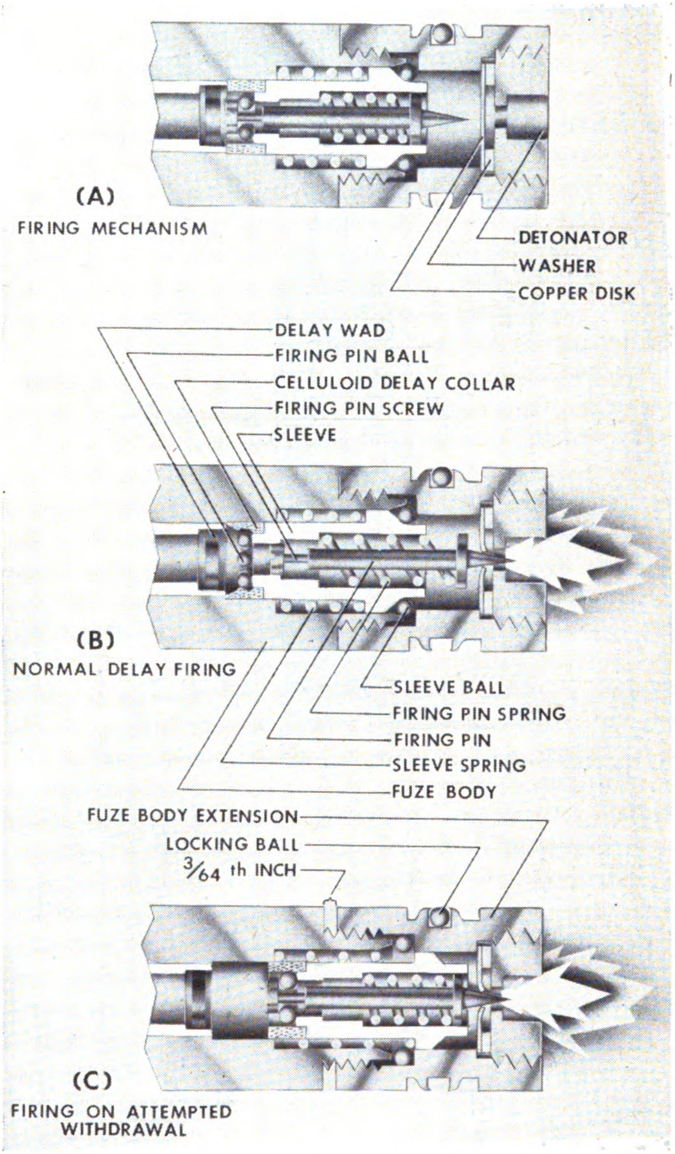


Figure 4-13.—Cutaway views of firing mechanism in various positions AN–M123A1 series fuzes.

loid collar. This assembly is mounted in a sleeve. The sleeve is held in place against the action of a compressed sleeve spring by a circle of balls bearing on a shoulder of the sleeve and held in position by the lip of the fuze body.

When the fuze is released armed, the arming vane rotates, turning the arming stem into the fuze body, breaking the glass ampoule, and seating a collar on the stem against a rubber washer, thus sealing the outer end of the fuze. The alcohol-acetone solvent from the ampoule filters through the delay wad and starts to dissolve the celluloid collar. The collar dissolves sufficiently to release the FIRING PIN BALLS in approximately the specified time. When released, the balls are forced outward by the firing pin screw and the firing pin is driven against the detonator by the firing pin spring. When a delay of 24 to 144 hours is used, the solvent must first dissolve a celluloid disk before starting action on the celluloid collar.

Antiwithdrawal action is as follows: The ball groove on the body extension is shallow on one end and deep at the other, so that as the fuze is being installed in the bomb, the locking ball is in the deep section and clear of the adapter booster wall. But once installed, if the fuze is turned counterclockwise (unscrewed), the ball is forced into the shallow end so that it jams between the body extension and booster adapter, locking the body extension in place. Any further motion of the fuze in the direction of unscrewing will unscrew the body from the body extension, and when the two have separated three sixty-fourths of an inch—a quarter turn of the fuze body—the SLEEVE BALLS are released and moved outward. The sleeve, carrying the firing pin, is driven forward by the sleeve spring, causing the firing pin to strike the detonator and explode the bomb.

These fuzes should not be installed until just prior to takeoff. Check for leaks by looking into and smelling the detonator cavity; the solvent has a distinctive odor and may be easily detected. A copper disk and aluminum washer is then inserted into the detonator cavity; these items serve to seal the lower end of the fuze against solvent leakage. The primer detonator used in the fuze is shipped separately, and is then screwed tightly into the detonator cavity. Screw the fuze into the bomb (see next paragraph), install arming vane, arming wire, and secure locknut. The shipping clip must be removed from the locking ball prior to installation.

Caution: (1) These fuzes must be regarded as ARMED at all times. Any fuze which has been dropped more than 10 feet, or subjected to temperatures above 170° F., or which has had the VANES FREE TO ROTATE must be considered armed and shall be destroyed. (2) Follow instructions in shipping box regarding use and disposition after exposure to high storage temperatures. (3) The natural tendency when engaging the threads of mating parts (as when installing a fuze) is to turn one part back and forth until the threads engage. Do NOT DO THIS. EXTREME CAUTION must be used to assemble the fuze to the bomb with a SCREWING-IN MOTION ONLY. THE ANTIWITHDRAWAL DEVICE WILL DETONATE THE FUZE IF IT IS ROTATED BACKWARD IN THE ADAPTER EVEN BEFORE THE THREADS ARE ENGAGED. NEVER, FOR ANY REASON, ATTEMPT TO REMOVE THE FUZE FROM A BOMB. IT WILL DETONATE.

Bomb Tail Long-Delay Fuzes M132, M133, and M134

These vane-operated impact fuzes have a nominal fixed 10-minute delay which actually will vary from 6 to 80 minutes depending on temperature. The arming mechanism has a gear reduction system, but only 100 feet of air travel is required for arming. Fuzes M132, M133, and M134 may be used in the same bombs as fuzes AN–M123A1, AN–M124A1, and AN–M125A1, respectively.

These fuzes contain an antiwithdrawal device which is identical to that used in the AN–M123A1 series. The time delay mechanism is somewhat different as it has a metal bellows containing a red colored solvent. The solvent acts upon a celluloid cylinder to produce the delay action.

When shipped, the detonator holder is not installed, and the fuze cavity is plugged with a wad of absorbent cotton. If there has been a leakage of solvent, the red color will be plainly visible on the cotton when removed.

General installation instructions already given for the AN–M123A1 series fuzes also apply to M132 series. Unlike most fuzes the fuze is tightened in the bomb with a wrench.

Special safety precautions previously noted for the AN–M123A1 series fuzes apply to the subject fuzes and must be followed. Bombs with these fuzes installed must **NEVER** be returned to carriers or airfields. Once installed, **NO ATTEMPT MUST BE MADE TO REMOVE THE FUZE FROM THE BOMB.**

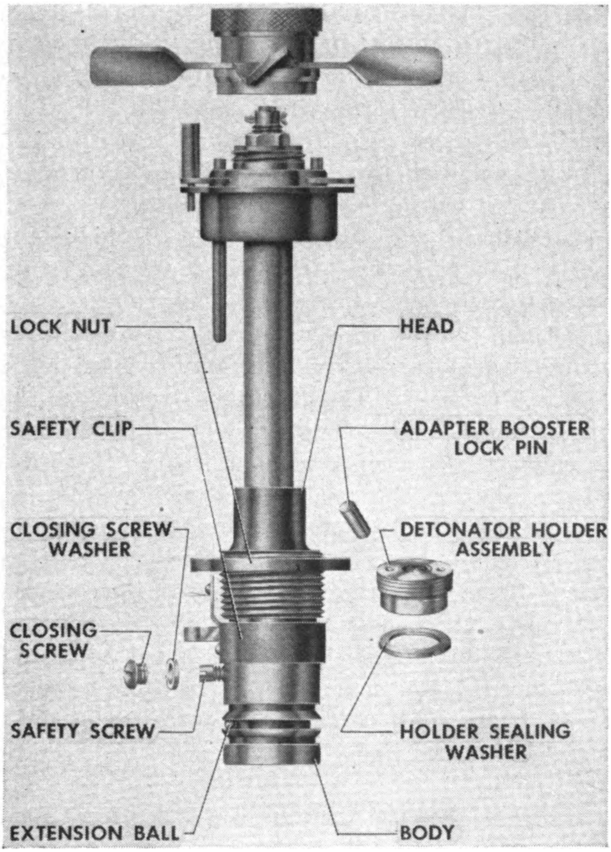


Figure 4–14. Bomb Tail Long-Delay Fuzes M132, M133, and M134.

Bomb Tail Fuze AN–Mk 228

The AN–Mk 228 is a vane-operated, long arming delay, impact fuze with a fixed delay time of 0.08 second. It is used only in 1,000-pound and 1,600-pound armor-piercing bombs, and requires approximately 1,100 feet of air travel to arm. This fuze has a reduction gear train in the arming system and in the unarmed condition the primers are out of line with both the firing pin extensions and the booster lead-ins. The fuze is safe for landings and takeoffs anywhere.

The AN–Mk 228 has two explosive trains for greater reliability. They consist of primer, delay element, detonator, auxiliary booster lead-in, booster separator lead-in, booster lead-in, and booster. Both trains lead to the tetryl booster charge located in the base of the fuze.

The fuze is bottle shaped and has a 16-bladed arming vane which is painted red for easy identification.

The operation of the AN–Mk 228 is as follows (refer to fig. 4–15): When the bomb is released armed, the arming vane is rotated by the air stream. This rotation is transmitted through the vane shaft and cap. The cap is secured to the pinion gear carrier, and the pinion gears circle the upper and lower gears. The gearing is so arranged that the lower gear cannot turn as long as the lug on the lower gear carrier engages a slot of the inner sleeve; therefore, the upper gear takes up the rotation and advances the central shaft on its threads until stopped by the shoulder on the shaft screw at the bottom of the central shaft. Twenty-three turns of the vane are required to turn the central shaft once. As the central shaft advances upward, it raises with it the gear assembly and striker. The striker, with its firing pin extensions, is now in the armed position; however, the extensions, firing pins, primers, delay elements, and detonators are still out of line. This completes the first arming stage.

The second stage in the arming process begins at about the same instant the central shaft completes its upward travel. At this moment the lug on the lower gear carrier is lifted clear of the slot in the inner sleeve, thus unlocking the lower gear and carrier. As the rotation of the central shaft and upper gear is stopped, the motion is transferred to the lower gear and carrier, and the pinion rotates them through approximately 175°. As the pinion rotates the lower gear and carrier, the firing pin extensions, firing pins, and components of each explosive train are lined up with the booster lead-ins. Detents then lock both the inner sleeve and lower gear carrier, insuring proper alignment of all firing parts.

In this position the fuze is fully armed and rotation of the arming vane will cease. Should the fuze be subjected to windspeeds in excess of 300 miles per hour after arming is completed, the vane will transmit enough force to shear the pins in the lower gear and carrier. Under this condition the vane will rotate without any effect on the armed fuze.

On impact, the striker and lower gear carrier are driven forward shearing the shear pin through the supporting collar and shaft. The firing pin extensions strike the firing pins which extend slightly above the surface of the delay element assemblies, setting off the primers, and initiating the explosive trains. The fuze will function on impact with 5/8-inch thick armor, or with water when dropped from 4,500 feet or higher.

Armed or partially armed fuzes: A small glass window is placed in the side of the fuze to permit visual inspection. If **unarmed**, the upper surface of the striker and the lower edge of the cap are about flush with the top edge of the outer sleeve. If **armed or partially armed**, the striker and cap will have separated from the upper sleeve edge. It is practically impossible to tell from visual examination whether a fuze is fully armed or very nearly armed; to be completely armed the striker should have moved out from the outer sleeve about 11/32 inch and the striker rotated 175°. If the full rotation has not taken place, the fuze is not armed; however a fuze with a separation between striker and sleeve of more than 3/16 inch must be considered armed. If the separation is less than 3/16 inch, it is partially armed and should be handled in accordance with Ordnance Pamphlet 988—*Bomb Fuzes*.

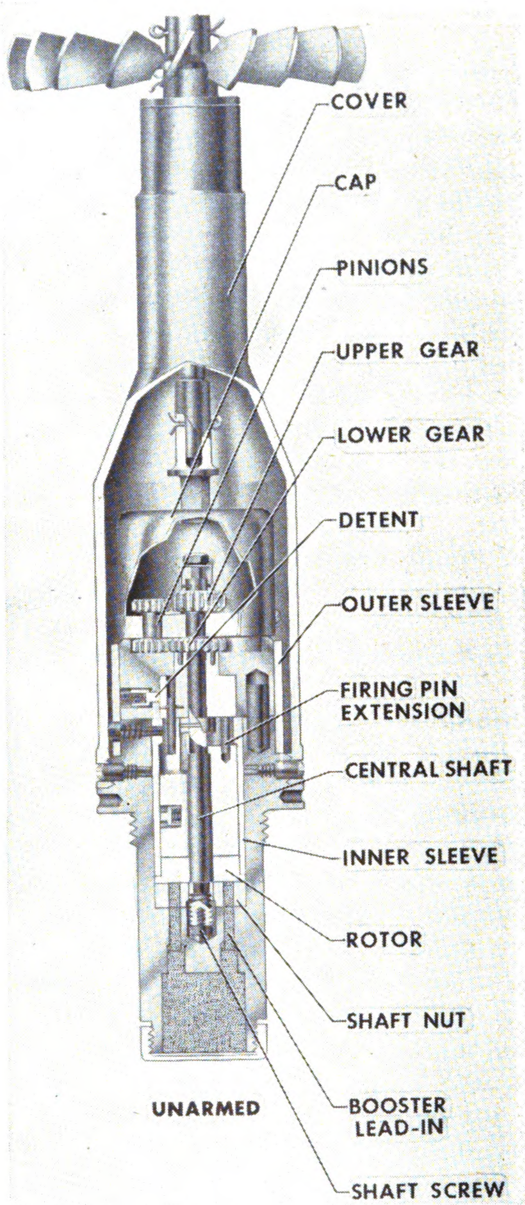


Figure 4–15.—Armed and unarmed views of Bomb Tail Fuze AN–Mk 228.

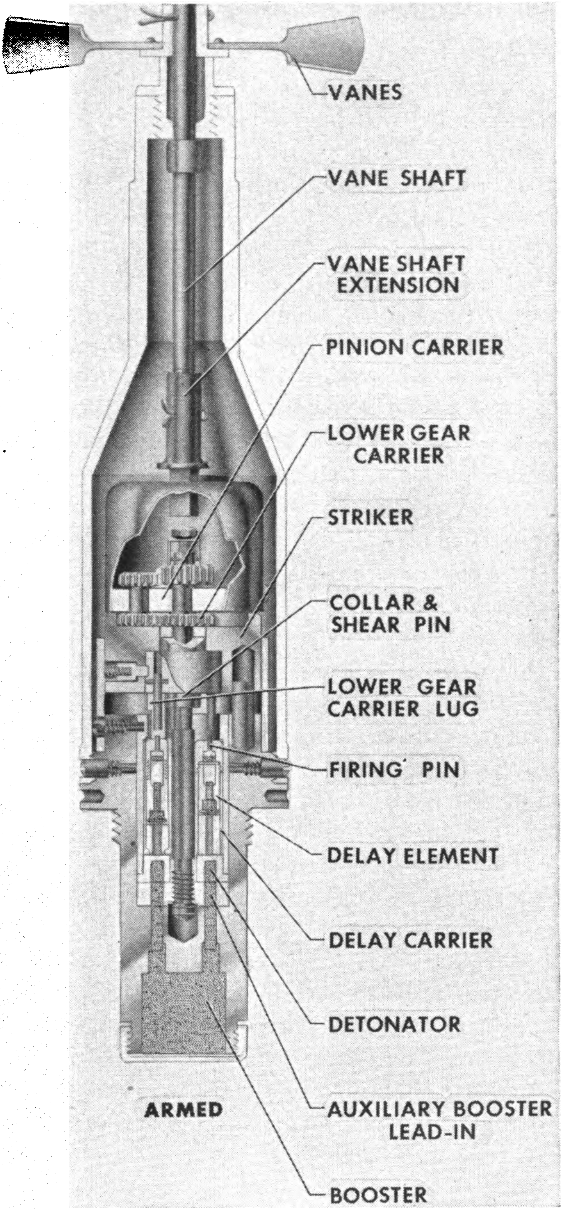


Figure 4–15.—Continued

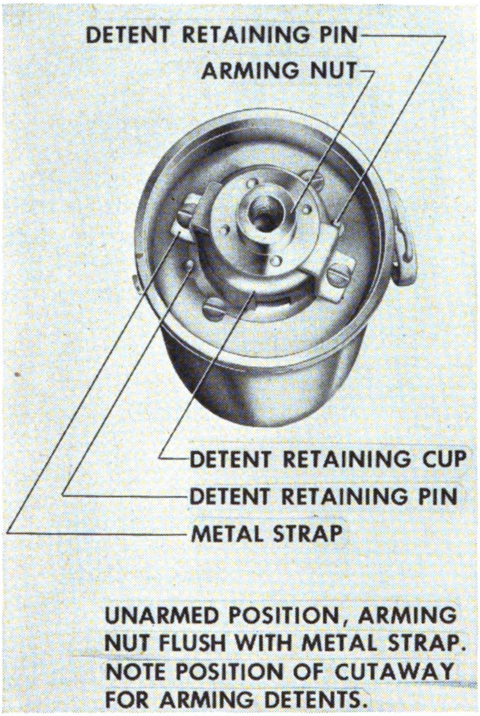
Bomb Tail Hydrostatic Fuze AN–Mk 230 Mods 4, 5, and 6

The Mk 230 is intended for use primarily in attacks on submarines and may be used in depth bombs, 500-pound, 1,000-pound, and 2,000-pound GP bombs. It is armed by vane, and after the required air travel of 400 to 500 feet it will function at predetermined depth settings of 25, 50, 75, 100, or 125 feet. Changes in depth setting are made by an external depth setting knob. AN–Mk 230 Mod 4 has the accuracy of the 50-foot setting emphasized and the 25-foot setting relaxed, while AN–Mk 230 Mods 5 and 6 have the accuracy of the 25-foot setting emphasized and the 50-foot setting relaxed. Otherwise the fuzes are essentially the same.

AN–Mk 230 and modifications have long arming delay and the detonator is out of line with the booster lead-ins when in the unarmed position. Hence the fuze is safe for landing and takeoff anywhere.

The operation of the AN–Mk 230 is as follows (refer to fig. 4–17): After armed release, the arming vane rotates in the windstream. This causes rotation of the vane shaft and gear cover with its attached pinions. The pinions circle around the upper and lower gears; since the lower gear is fixed, the circling of the pinions "walks" the upper gear around, rotating the arming shaft once to 23 revolutions of the vane. As the arming shaft rotates, its threads screw into the arming nut, raising it. The arming nut cannot rotate as the pins are engaged with the holes in the arming detent carrier. The arming nut is screwed into the arming shaft until jammed by its washer, at which time the arming nut pins are free of the detent carrier and the arming nut is allowed to rotate. Further rotation of the arming shaft results in rotation of the arming nut, and since the pins are still engaged in the detent retaining cup, the cup is also forced to turn. The detent retaining cup turns 85° to line up two cutouts in the cup with the arming detents, thus allowing the detents to jump out, freeing the depth spring stem nut. The fuze is now armed.

On impact, the inertia counterbalances prevent premature firing of the fuze due to the force of inertia. Water enters through two ports in the body sleeve and holes in the depth setting mechanism housing. Hydrostatic pressure extends the bellows and forces the hydrostatic piston downward, compressing the depth spring and firing spring as it moves. The firing plunger contains the detonator and lead-out charges and is locked to the plunger housing by six balls. After the hydrostatic piston has moved downward about three-eighths of an inch (the distance is the same for all depth settings), the balls locking the firing plunger jump out into the recess in the hydrostatic piston. The compressed firing spring forces the plunger into the firing point thereby simultaneously aligning the explosive trains and initiating successively the detonator, lead-out charges, lead-in charges, relay pellets, and booster charge.



UNARMED POSITION, ARMING NUT FLUSH WITH METAL STRAP. NOTE POSITION OF CUTAWAY FOR ARMING DETENTS.

Figure 4–16.—Arming mechanism (unarmed) of AN–Mk 230 Mod 4.

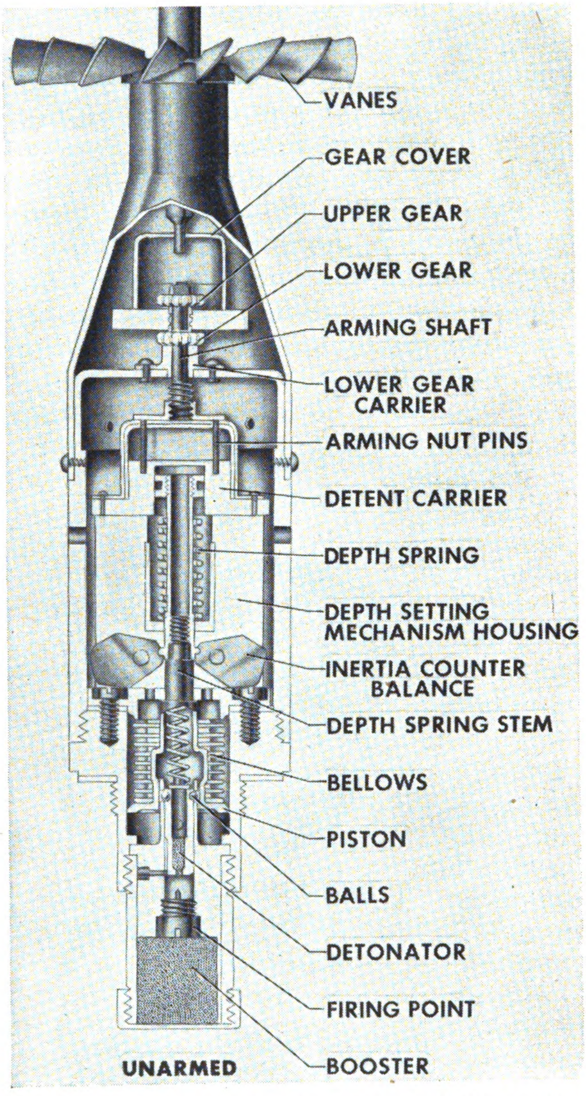


Figure 4–17.—Unarmed and armed views of AN–Mk 230 Mod 4.

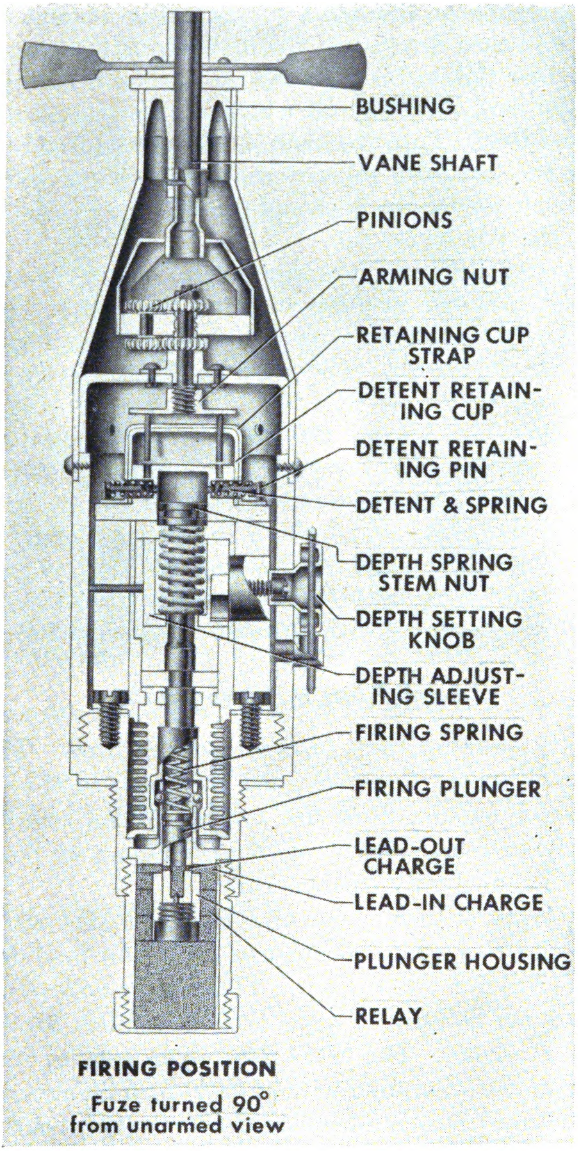


Figure 4–17.—Continued

The external depth setting knob determines the amount of compression on the depth spring. The amount of compression in turn determines the hydrostatic pressure needed to overcome the spring. To change the depth setting, withdraw the depth setting rod which is inserted through the knob and lock. Turn the knob so that the desired setting is nearest the lock, and reinsert the depth setting rod in the appropriate hole in the knob and through the slot in the lock. Install the rod cotter pin.

When installing the fuze in a bomb, be sure the neoprene "O" ring gasket is in place and that the fuze is tightened securely with a spanner wrench to insure a watertight seal. The safety rod must be removed from the fuze body prior to installation.

Caution: The AN–Mk 230 has no external indication of arming. Since water pressure is required to detonate the fuze, an armed fuze can be safely removed from a bomb. In this case, the safety rod locking the firing plunger to the plunger housing should be inserted as soon as possible. Fuzes suspected to be fully or partially armed should be handled in accordance with Ordnance Pamphlet 988—*Bomb Fuzes.*

Bomb Fuzes M154 and M157

Strictly speaking, these fuzes are not tail fuzes. They are "all-ways" impact fuzes designed for use with the various igniters for napalm filled fire bombs. When armed, both types are extremely sensitive to any impact or blow and must be handled with extreme care.

Fuze M154 is used in igniters M13 and M14 which are filled with either white phosphorus (WP) for land drops or sodium (Na) for water drops. This fuze is noncarrier safe and must not be used by naval activities unless M157 fuzes are not available. The M154 fuze is an arming pin type which requires an arming wire of 0.036-inch diameter; when released armed, a spring-loaded release pin jumps out. This allows a spring-loaded safety pin to move, arming the fuze. On impact from any angle the striker and the firing pin

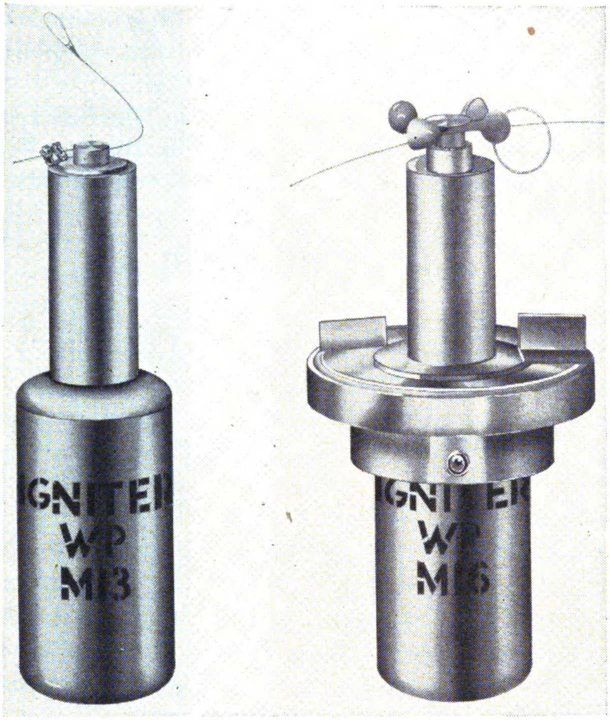


Figure 4–18.—Igniter M16 (Fuze M157) and Igniter M13 (Fuze M154).

strike the primer, which ignites the booster. The booster detonates the burster (a blasting cap and 5½ grams of tetryl) which scatters the igniter filler into the napalm mixture, causing ignition. IF THE ARMING WIRE IS MISSING FROM THE FUZE, THE FUZE IS ARMED.

Fuze M157 is armed by rotation of its anemometer type vane (see fig. 4–18). After 18 vane revolutions, or approximately 150 feet of air travel, the fuze is armed for impacts along the axis of the fuze. After 30 vane revolutions or about 220 feet of air travel, the fuze will function on impact from any angle. Arming is accomplished by withdrawal of a safety rod from the striker body, unlocking the striker. The action on impact is the same as that of the M154. Bomb

Fuze M157 is carrier-safe and is used in igniters M15 and M16 which use the same fillers and explosive components as igniters M13 and M14.

Caution: If the arming vane is missing, the fuze is armed. If the vane assembly has separated from the fuze body by more than one-eighth of an inch, the fuze must be considered armed.

SAFETY PRECAUTIONS

These safety precautions are general in scope; many of the fuzes described herein have special precautions applicable only to them. Before handling any fuze with which you are not thoroughly familiar, read and understand the precautions dealing with that fuze. These precautions are listed in the Ordnance Pamphlets and other publications concerning the specific item, such as OP 988—*Bomb Fuzes*.

DO NOT ATTEMPT TO DISASSEMBLE, ALTER, OR REPAIR ANY FUZE. Some Navy-type fuzes may be disassembled for cleaning after exposure, or for disarming, but this should NEVER be done unless absolutely necessary and then only if it is impossible to turn the fuze in or if it MUST be used. Under these extreme conditions, personnel thoroughly familiar with the fuze MAY BE authorized to disassemble it to the extent authorized by the Bureau of Ordnance. It is impossible to disassemble most service fuzes; should they become corroded (or otherwise unserviceable) or armed, they must be disposed of in accordance with current instructions.

Fuzes should not be installed in bombs until just prior to or after loading the bombs onto aircraft. In general, fuzing shall be done on individual rounds isolated from other ammunition insofar as possible. No smoking is allowed within 25 feet of fuzing operations.

Fuzes must be handled carefully at all times. An arming wire or safety pin must be in place in the fuze AT ALL TIMES. Armed fuzes are extremely dangerous; some types need only a blow IN ANY DIRECTION equivalent to a drop of ONE INCH to detonate.

Fuzes shall be stored only in specially designated fuze magazines which shall not be adjacent to magazines containing high explosives. Fuzes should always be stored in a cool, dry location.

Use the proper fuze in bombs. Always inspect the fuze cavity and threads carefully and if necessary, wipe the cavity out with a clean dry cloth and clean the threads with a pointed WOODEN stick prior to fuze installation. Should the threads be burred or otherwise damaged, never force the fuze while installing.

Tail fuze primer detonators, such as M14 and M16A1, must be handled carefully and never dropped. Do not strike them or permit them to strike anything.

Most fuzes should be installed in the bomb handtight. A very few (such as the hydrostatic fuze AN–Mk 230) require tightening with a wrench.

Bombs assembled with any type of fuze that cannot be removed, either because of jamming or antiwithdrawal features, must be jettisoned over enemy territory or into deep water if they cannot be dropped on the target. They must never be returned to a carrier or airfield. **NEVER ATTEMPT TO REMOVE AN ANTIREMOVAL FUZE FROM A BOMB.**

Detonators which are not assembled to or sealed in fuzes must not be stored in the same magazine with fuzes.

Never turn the arming vane of a fuze more than one-half turn in either direction. When installing the arming wire in a fuze, it is sometimes necessary to turn the vane a slight amount in order to line up the holes through which the arming wire is passed.

QUIZ

1. The two general methods of arming a bomb fuze are by ---------- and ----------.
2. What is used to prevent the fuze from arming until the bomb is released?

3. The AN–M103A1 nose fuze can be set for either instantaneous or ---------- second delay functioning.

4. Bomb Nose Fuze AN–Mk 243 Mod 0 is a vane-operated, ---------- ---------- fuze.

5. Mechanical Time Fuze AN–M146 can be set to function from ------ to ------ seconds after armed release.

6. The two types of proximity (VT) fuzes are ---------- type and ---------- type.

7. The five delays of M14 primer detonators are --------, --------, --------, --------, and -------- second.

8. Bomb fuzes of the ---------- series are designed for low-level masthead bombing.

9. Bomb Fuze AN–M123A1, AN–M124A1, and AN–M125A1 have delay times ranging from ------ to ------.

10. TRUE OR FALSE: If an aircraft loaded with bombs fuzed with AN–M124A1 fuzes returns its bomb load to the carrier, the bombs should be unfuzed as rapidly as possible, and the fuzes returned to the magazine.

11. Bomb Tail Fuze AN–Mk 228 is for use only in ---------- bombs.

12. Bomb Tail Fuze AN–Mk 230 and Mods require both ---------- and ---------- to function.

13. Fuze M157 is used in ---------- bombs.

14. TRUE OR FALSE: When AN–M103A1 nose fuzes become dirty or corroded, they must be disassembled and cleaned.

CHAPTER 5

AMMUNITION

Ammunition is described in the *Bureau of Ordnance Manual* as, "All the components, and any and all explosives in any case or contrivance prepared to form a charge, complete round, or cartridge for cannon or small arms, or for any other weapon, warheads, mine, bomb, depth charge, demolition charge, fuze, detonator, projectiles, etc.; all signaling and illuminating pryrotechnic materials; and all chemical warfare materials under the cognizance of the Bureau of Ordnance and used by the Navy for offensive, defensive, saluting, and training purposes."

It can be seen that ammunition, thus defined, is a very broad subject. However, Aviation Ordnancemen in referring to "ammunition" usually mean specifically small-arms and other gun ammunition rather than the many types enumerated in the official Bureau of Ordnance definition given above. This chapter deals only with small-arms, 20-mm, and special ammunition—other types being covered elsewhere in this text.

SMALL-ARMS AMMUNITION

Ammunition used in weapons whose bore is 0.60-inch or less (rifles, carbines, pistols, revolvers, and machine guns) and in all shotguns is classed as small-arms ammunition.

A round of small-arms ammunition (shotgun shells excepted) is known as a CARTRIDGE. In general, a cartridge consists of a bullet, a propelling charge, a primer, and a cartridge case, all made up into a unit assembly. Shotgun shells and caliber .45 shot cartridges contain a charge of small pel-

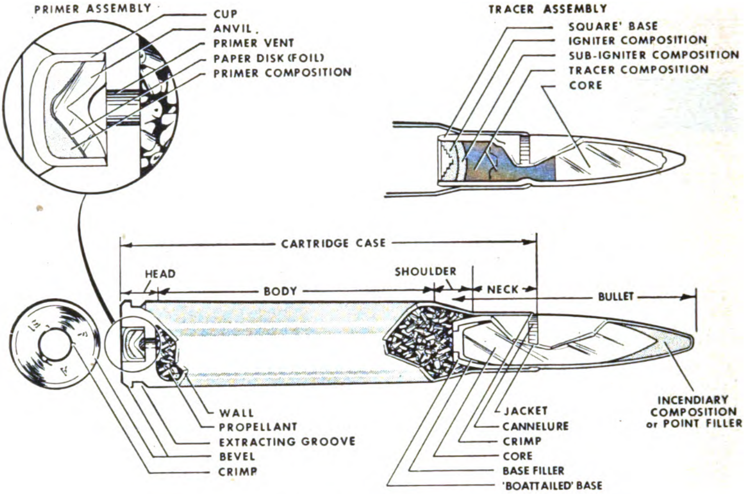


Figure 5–1.—Cartridge terminology.

lets or shot instead of a single bullet. Cartridge terminology and component parts are shown in figures 5–1 and 5–2.

Bullet.—Bullets for service use have a metal core or slug which is covered with a gilding metal (90 percent copper—10 percent zinc) or gilding-metal-clad steel jacket. In the case of caliber .45 bullets, copper-plated steel may be used instead of gilding metal for the jacket. Ball and tracer bullets have a lead alloy or common steel core or slug, whereas armor-piercing bullets have a hardened steel alloy core. Bul-

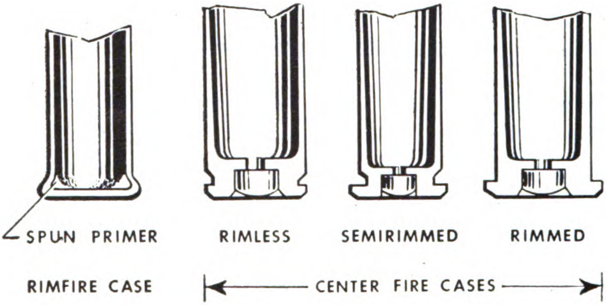


Figure 5–2.—Cartridge terminology—continued.

lets have either a flat or tapered base. A bullet having a tapered base is said to be "boattailed." A cannelure, or annular knurl, is rolled or cut into the jacket to provide a recess into which the cartridge case is crimped.

Propelling charge.—There are two types of small-arms propellants generally used, the single-base nitrocellulose type and the double-base type. The double-base type is a mixture of nitrocellulose and nitroglycerin which burns more rapidly than the single-base type; it is used in shotgun shells, some caliber .45 rounds, and carbine ammunition. The weight of the charge and granulation of the powder vary with specification requirements for velocity and pressure. The charge is assembled loosely in the cartridge case.

Primer.—The primer consists of a brass or gilding-metal cup which contains a primer-composition pellet of sensitive explosive, a paper disk, and a brass anvil. A blow from the firing pin on the primer cup compresses the primer composition between the cup and the anvil, and causes the composition to explode. The holes or vents in the anvil allow the flame to pass through the primer vent in the cartridge case and ignite the propellant.

Cartridge case.—The cartridge case is made of drawn brass or steel. It serves as a means whereby the other components—primer, propelling charge, and bullet—are assembled into a unit, the cartridge. Another of its functions is to expand and seal the chamber against the escape of gases to the rear when the cartridge is fired. To make the cartridge waterproof and to keep the propelling charge dry, the primer is sealed in the primer seat and the bullet is sealed in the neck of the cartridge case by a thin film of lacquer or varnish at the time of manufacture. An extractor groove, turned in the head of the cartridge case, provides a means of removing the case from the chamber of the weapon.

Caliber

The caliber of a small-arms weapon is the diameter of the bore (measured between opposite lands) expressed in inches, or for weapons of foreign origin in millimeters. The lands of the rifling of a weapon are the raised spiral portions of the rifling formed by cutting spiral grooves, generally 0.003- or 0.004-inch deep into the surface of the bore. The diameter of the lead alloy bullet is generally 0.003-inch greater than the bore diameter between grooves. The diameter of a jacketed bullet generally should not be more than 0.001-inch greater than the bore diameter between grooves.

Gage

Instead of caliber, shotgun shells are identified as to size by "gage." The gage of a shotgun refers to the number of pure lead balls of the diameter of the bore required to weigh 1 pound. The .410-gage is an exception in that the diameter of the bore is 0.410-inch. The bore of a 12-gage shotgun measures 0.729-inch in diameter; thus 12 lead balls of 0.729-inch would weigh 1 pound.

Classification

Small-arms ammunition is classified as SERVICE or SPECIAL, depending upon its purpose.

Service types are as follows:

BALL, for use against personnel and light material targets.

ARMOR-PIERCING (AP), for use against armored aircraft and lightly armored vehicles, concrete shelters, and other bullet-resisting targets.

INCENDIARY (INC), for incendiary effect, especially against aircraft.

TRACER (TR), for observation of fire. Secondary purposes are for incendiary effect and for signaling.

ARMOR-PIERCING-INCENDIARY (API) for combined armor-piercing and incendiary effect.

ARMOR-PIERCING-INCENDIARY-TRACER (API-T), for combined armor-piercing and incendiary effect, with the additional tracer feature.

Special types:

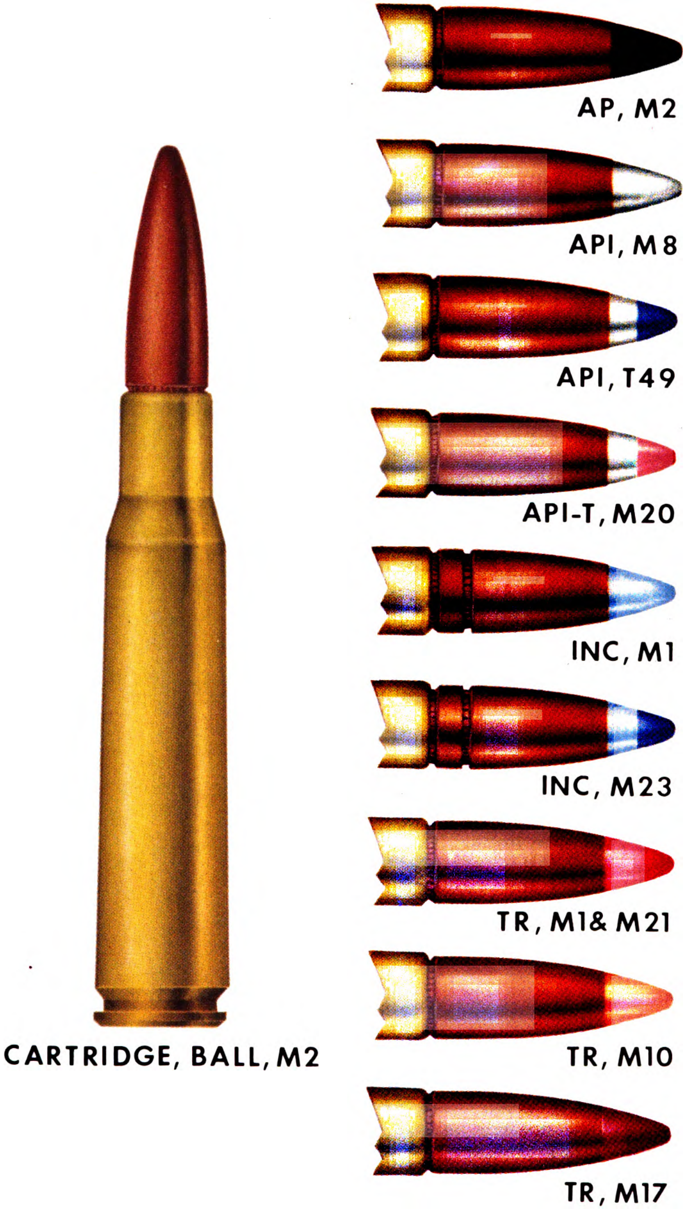


Figure 5–3.—Caliber .50 cartridges.

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bullet

C

CA

Blank, for simulated fire, and for saluting (contains no bullet).

Dummy, for training and testing purposes only. (Completely inert.)

Identification

The type, caliber, model, and ammunition lot number, including the symbol of the manufacturer are necessary for complete identification of small-arms ammunition. For caliber .30 and .50, the grade is also necessary.

From the cartridge itself, the ammunition may be identified, except for lot number, by the following:

The appearance of the cartridge and the painting on the bullet (see figs. 5–3, 5–4, and 5–5; also table 5–1).

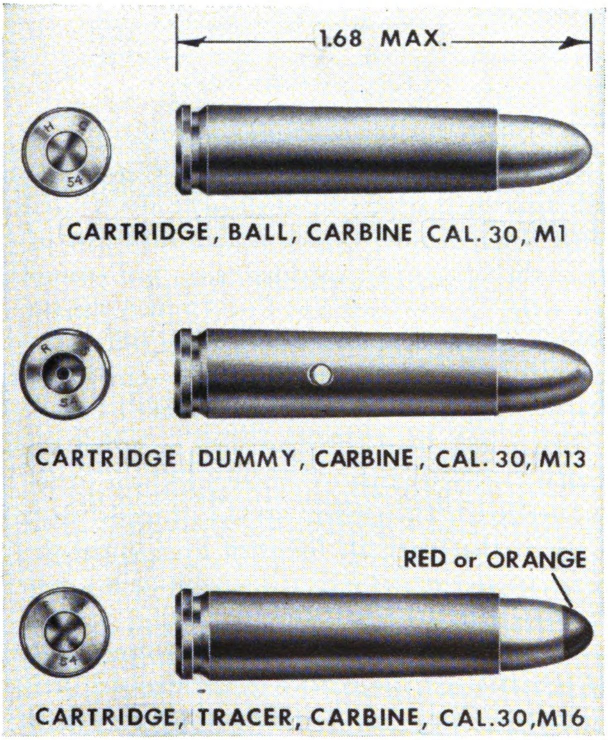

1.68 MAX.
54
CARTRIDGE, BALL, CARBINE CAL. 30, M1
54
CARTRIDGE DUMMY, CARBINE, CAL. 30, M13
RED or ORANGE
54
CARTRIDGE, TRACER, CARBINE, CAL.30,M16

Figure 5–4.—Caliber .30 carbine cartridges.

Table 5–1.—Identification of cartridges by color of bullet tip.

Color of tip of bullet	Type of cartridge
No color	Ball.
Black	Armor-piercing.
Aluminum color	Armor-piercing-incendiary.
Blue	Incendiary.
Red	Tracer—cal. .30 and cal. .50, M1; cal. .50 headlight tracer, M21; carbine, M16; and cal. .45, M26 (T30).
Maroon	Tracer—cal. .50, M17 (T9).
Orange	Tracer—cal. .50, M10; carbine, M27 (T43); and cal. .30, M25 (T10).
Red with aluminum color rear annulus (see fig. 5–3).	Armor-piercing-incendiary-tracer.
Blue with light blue rear annulus.	Incendiary—cal. .50, M23 (T48) only.
Blue with aluminum color rear annulus.	Armor-piercing-incendiary—cal. .50, (T49) only.

The stamping on the base of the cartridge case. Because of its small size, the marking on small-arms ammunition is the stamping of the manufacturer's initials and year of manufacture on the base of the cartridge case. For example, "FA 49" means the lot was loaded at Frankford Arsenal in 1949.

Markings on the original packing boxes and cartons.

MODEL.—To distinguish a particular design, a model designation is assigned at the time it is classified as an adopted type. The model designation becomes an essential part of the standard nomenclature of the item and one of the means of identification. The present system of model designation is the use of the letter M, followed by a numeral, just as bombs, mines, and other types of ammunition are designated. For example, CARTRIDGE, ball, Cal. .50, M2.

When a particular design has been accepted only for a limited procurement and service test, the model designation is indicated by the letter T, followed by a numeral. For example, CARTRIDGE, armor-piercing-incendiary, Cal. .50, T49. At such a time as the design is standardized, the M designation is assigned.

Ammunition lot number.—When ammunition is manufactured, an ammunition lot number, which becomes an essential part of the marking, is assigned in accordance with pertinent specifications. This lot number is marked on all packing boxes containing carton-packed cartridges, and on the cartons packed therein. It is required for all purposes of record, including grading, use, and reports on condition, functioning, and accidents in which the ammunition might be involved.

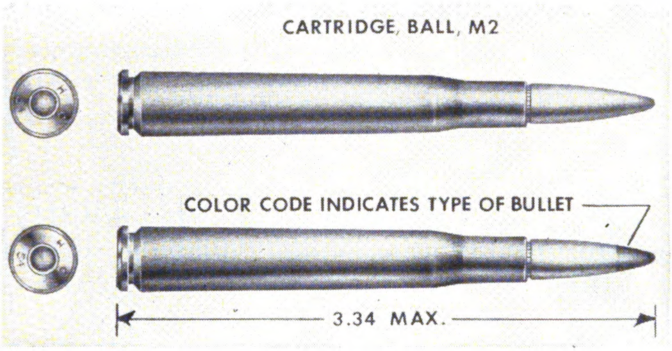


Figure 5–5.—Caliber .30 cartridges.

Since it is impracticable to mark the ammunition lot number on each individual cartridge, every effort should be made to preserve, by tagging or marking, the ammunition lot number of cartridges once they are removed from their original packing. Cartridges for which the ammunition lot number has been lost automatically become grade 3.

As far as practicable, all complete rounds of any particular ammunition lot are made up of components selected from the same lot. To obtain the greatest accuracy in firing, successive rounds should be fired from the same ammunition lot.

Ammunition grades.—Ammunition is manufactured to rigorous specifications and is inspected and tested thoroughly before acceptance. Since the various types of weapons have different requirements, production orders and specifications

Table 5–2.—Symbols used in ammunition grading.

Grade symbol	Authorized use
For caliber .30:	
Grade *AC*; or *AC/R*	For aircraft machine guns.
Grade *MG; R; AC/R;* or *AC*	For ground-type machine guns including those mounted for antiaircraft.
Grade *R; AC/R;* or *AC*	For rifles; semiautomatic and automatic.
Grade 3	Unserviceable. **Not to be issued or used.**
For caliber .50:	
Grade *AC*	For aircraft machine guns.
Grade *MG;* or *AC*	For antiaircraft machine guns.
Grade 3	Unserviceable. Not to be issued or used.

call for the classification of lots for use in specific weapons. Variations in manufacture may occur because of problems of mass production of ammunition. Considering variations from lot to lot and the different requirements for each type of weapon, grades are assigned to each lot of ammunition, in accordance with acceptance tests, to designate their use in the different types of weapons. It should be noted that grade designations (when assigned) do not signify that one grade is better than another, but that it is better for some particular class of weapon.

Current grades of all existing lots of small-arms ammunition are published in Bureau of Ordnance Instructions. Any lots on hand which are not listed in current Instructions should be reported to the Bureau of Ordnance immediately.

The grades for small-arms ammunition are shown in table 5–2. Note that grade 3 is not to be issued or used.

Manufacture of Cartridge Cases

The cartridge case is made from a circular disk of brass which is punched into the form of a cup and shaped by drawing through successive dies. The closed end is pressed into shape to form the head in which the primer pocket and vent are then formed. An extractor groove is machined around the head to provide a grip for the mechanical extractor of the weapon. Pistol ammunition cases are cylindrical; carbine ammunition cases taper slightly; rifle and machine gun ammunition cases taper slightly from the head to the shoulder (approximately three-fourths of the length) then sharply at the shoulder to the cylindrical neck. After punching or drawing operations, the case is annealed to remove strains. The annealing process is intended to give the proper hardness and toughness to the case. The final case has a hard and tough head. The rim is hardened to withstand the pull of the extractor, and the side walls are rendered soft but resilient

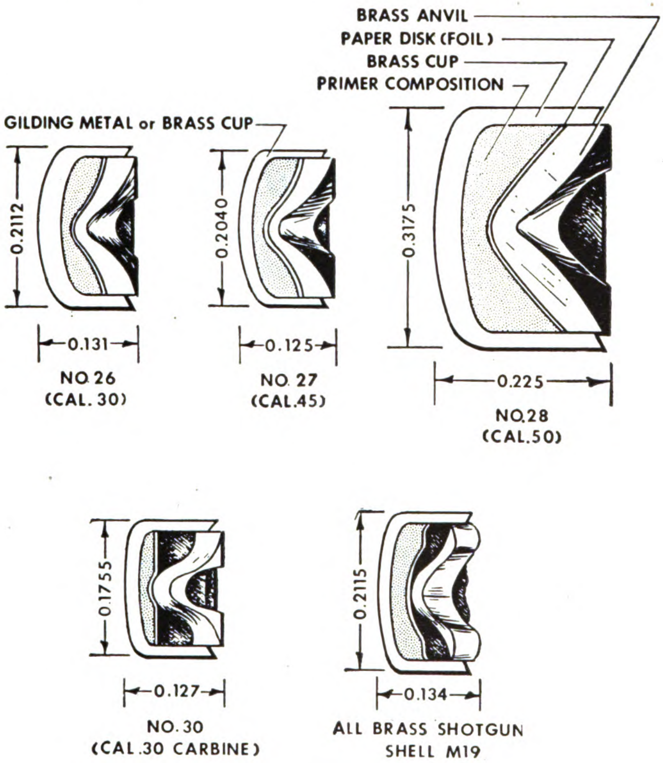


Figure 5–6.—Primers—sectioned.

enough to spring back after expansion. The mouth is annealed to a dark or bluish discoloration about the neck; this is done to prevent season cracking (discussed later in this chapter), and to facilitate crimping to secure the bullet.

The primer is pressed into the primer pocket and staked or crimped, and the joint is sealed by a drop of shellac or lacquer. (Figure 5–6 shows details of several primers.) The cartridge case is loaded with a charge of propellant powder and the inside of the neck coated with lacquer or other waterproofing compound. The bullet is then inserted, and the mouth of the case crimped into the cannelure of the bullet. For caliber .30 carbine and caliber .45 cartridges, the mouth of the case is not crimped to the bullet, but is held in place by its tight fit in the case. In some revolver cartridges a cannelure in the case prevents the bullet from being seated too deeply.

DESCRIPTION OF ROUNDS

Cartridge, Ball, Cal. .22, Long Rifle

These cartridges are procured from several commercial manufacturers and do not have any model designation. They are for use in all types and models of caliber .22 weapons.

The cartridge case is made of brass, copper, and gilding metal. The bullet is made of lead, and contains grease or wax in its cannelures for lubrication purposes in the bore of the weapon.

Average maximum chamber pressure is 20,000 pounds per square inch, and muzzle velocity is 1,100 feet per second. When fired into 1-inch pine boards, spaced 1 inch apart at a range of 15 feet, the bullet will penetrate the first 5 boards and slightly into the sixth board. (A penetration of 1 inch in pine corresponds to a serious wound.) Maximum range is 1,500 yards.

Cartridge, Ball, Carbine, Cal. .30, M1

This cartridge is a current standard item of issue for use in caliber .30 carbines. It is intended for use against personnel and light material targets for ranges up to 300 yards. Its length is 1.68 inches. Other caliber .30 carbine cartridges are shown in figure 5–4.

The bullet consists of two parts, a lead alloy core and the jacket of either gilding metal or gilding-metal-clad steel. When test fired for accuracy, it will group within a mean radius of 4 inches at 300 yards. The bullet will penetrate twelve ⅞-inch pine boards at 100 yards, 8 boards at 200 yards, and 7 boards at 300 yards. Average maximum chamber pressure is 40,000 pounds per square inch, and muzzle velocity is 1,970 feet per second. Maximum range is 2,200 yards.

Cartridge, Ball, Cal. .30, M2

This cartridge is a current standard item of issue and is used in machine guns and rifles. The length of the complete round is 3.34 inches. Ball cartridges do not have any paint or markings on bullet tips. Other caliber .30 cartridges are shown in figure 5–5.

The bullet consists of two parts, a gilding metal or gilding-metal-clad steel jacket and a lead alloy core. The average maximum chamber pressure is 50,000 pounds per square inch; average muzzle velocity is 2,800 feet per second. Maximum range is 3,450 yards while the effective range is 800 to 1,000 yards. At 600 yards the bullet will penetrate 1 inch of concrete, or four 2½-inch oak boards.

New Developments in Caliber .30

A new caliber .30 cartridge has been under development by the Army for several years and has recently been adopted as the new service rifle and machine gun cartridge, not only for the United States but for its allies, Great Britain, Canada, France, and Belgium, as well. This standardized cartridge will simplify manufacturing and supply problems. However, it will be several years before the cartridge will be widely issued, since some weapons must be modified to handle the new cartridge and others will be completely replaced with new types.

The cartridge is currently designated the T65 and is about 10 percent lighter than the current caliber .30, M2, and approximately ½-inch shorter in length; the complete round is about as long as the present .30 caliber case. Yet because ball-grain smokeless powder is used, as much propellant as is used in the M2 case can be packed in the shorter T65 case with the result that the bullet's muzzle velocity and other ballistics remain substantially the same as the M2's.

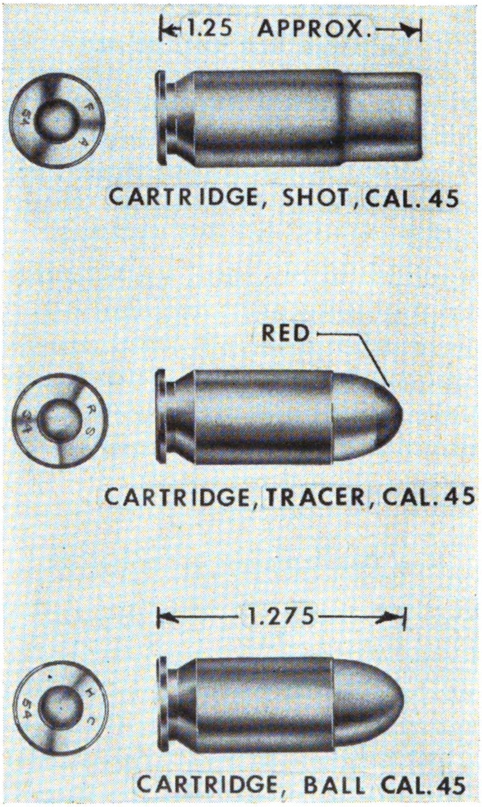


Figure 5–7.—Caliber .45 cartridges.

The T65 cartridge is already being marketed commercially under the name ".308 Winchester" for sporting use, the only difference being in the bullets which are sporting type instead of the full-jacketed military style.

Cartridge, Ball, Cal. .45, M1911

This cartridge is a standard item of issue and is used in the caliber .45 automatic pistols and submachine guns. (See fig. 5–7 for other caliber .45 cartridges.)

The bullet consists of a gilding metal, gilding-metal-clad steel, or copper-plated steel jacket and a slug of lead hardened with antimony. Muzzle velocity is 830 feet per second, and chamber pressure is 17,000 pounds per square inch. Penetration in white pine ranges from 6 inches at 25 yards to 4 inches at 250 yards. The penetration in moist loam at 25 yards is 10 inches, and in dry sand it will penetrate about 8 inches. Maximum range is 1,600 yards. (All the above data refer to firing in the M1911A1 pistol.)

Cal. .50 Ammunition

Ammunition for caliber .50 weapons is shown in figures 5–1, 5–3, and 5–8. Caliber .50 bullets are shown sectioned in

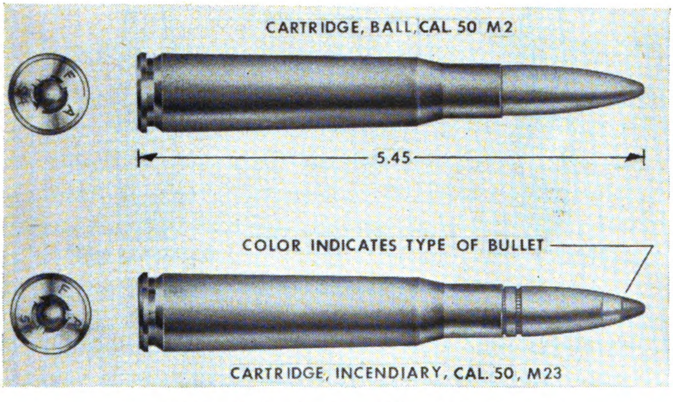

CARTRIDGE, BALL, CAL 50 M2
5.45
COLOR INDICATES TYPE OF BULLET
CARTRIDGE, INCENDIARY, CAL. 50, M23

Figure 5–8.—Caliber .50 cartridges.

figure 5–9. The trajectories of caliber .50 service types, except the incendiary M23 and API T49 cartridges for aircraft use, match at 600 yards. The time of flight does not differ by more than 1/10 second under specified conditions.

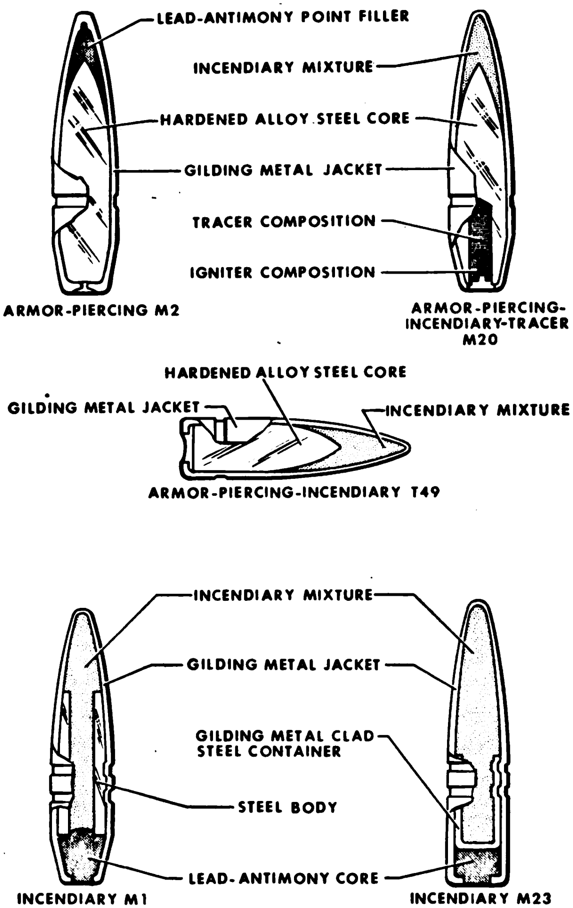


Figure 5–9.—Caliber .50 bullets—sectioned.

The incendiary M23 and API T49 cartridges, whose bullets weigh approximately 500 grains and have muzzle velocities of 3,450 feet per second, also have matched ballistics.

Cartridge, Armor-Piercing, Cal. .50, M2

This cartridge is a limited standard item of issue for caliber .50 machine guns. It is designed for use against armored aircraft, armored vehicles, concrete shelters, and similar bullet-resisting targets. It may be identified by the black bullet tip.

The bullet consists of three parts: a gilding metal jacket, a hardened core of steel, and a point filler of an antimony-lead alloy. Average maximum chamber pressure is 55,000 pounds per square inch. Muzzle velocity is 2,840 feet per second. Penetration of 1-inch armor plate is obtained at 200 yards.

Cartridge, Armor-Piercing-Incendiary, Cal. .50, M8

This cartridge is a current standard cartridge for caliber .50 machine guns. It replaces the incendiary cartridge M1 and armor-piercing cartridge M2 as standards for manufacture and issue. It is identified by the aluminum color of the bullet tip.

The bullet contains the same core as the M2 described above, but the point filler is replaced by an incendiary composition. Penetration ability is almost equal to that of the M2. The bullet will perforate 7/8-inch armor plate at normal impact at 100 yards, and 5/8-inch armor plate at 30° impact at 100 yards. Average maximum chamber pressure is 55,000 pounds per square inch, and muzzle velocity is 2,950 feet per second.

Cartridge, Armor-Piercing-Incendiary, Cal. .50, T49

This cartridge is a limited procurement item for use only in caliber .50 aircraft machine guns. It has a higher velocity than the API cartridge, M8, and is intended for use with the incendiary cartridge, caliber .50, M23 (T48), since it has similar exterior ballistics. It may be identified by the bullet tip, which is painted medium blue with an aluminum color annulus to the rear.

The bullet is shorter in length than API bullet, caliber .50, M8. Penetration ability is equal to that of the M8, chamber pressure is 58,000 pounds per square inch, and muzzle velocity is 3,450 feet per second.

Cartridge, Armor-Piercing-Incendiary-Tracer, Cal. .50, M20 (T28)

This cartridge is similar to the M8 cartridge, with the addition of a tracer element. Its use makes tracer cartridges unnecessary in machine gun belts. It is identified by the tip of the bullet which is painted red with an aluminum annulus to the rear.

A dim trace begins at 20 feet from muzzle to 300 yards, where it changes to a bright trace, which continues to approximately 1,750 yards. Complete penetration of ⅞-inch armor plate is obtained at 100 yards. Average maximum chamber pressure is 55,000 pounds per square inch, and muzzle velocity is 2,950 feet per second.

Cartridge, Ball, Cal. .50, M2

This cartridge is a standard item of issue for caliber .50 machine guns. The cartridge has no identification markings except the conventional stamping on the base.

The bullet consists of three parts: a gilding metal jacket, a soft steel core, and a point filler of antimony-lead alloy. Penetration of 2-inch concrete or 12 inches of sand is obtained at 200 yards. Average maximum chamber pressure is 53,000 pounds per square inch, and muzzle velocity is 2,840 feet per second.

Cartridge, Incendiary, Cal. .50, M23 (T48)

This cartridge is a standard item of issue for use only in caliber .50 aircraft machine guns. It has a higher velocity than the incendiary cartridge M1 and is more effective as an incendiary against aviation jet fuel. It may be identified by the bullet tip, which is painted medium blue with a light blue annulus to the rear.

The M23 bullet consists of a gilding metal jacket, a clad steel container, a lead-antimony base slug, and an incendiary composition. Average maximum chamber pressure is 58,000 pounds per square inch, and muzzle velocity is 3,450 feet per second.

Ammunition boxes.—Small-arms ammunition, as compared with other types of ammunition, is not dangerous to handle. Care, however, must be observed to keep the boxes from becoming broken or damaged. All broken boxes must be repaired immediately. Transfer all markings to the new parts of the box.

New procurement of small arms (except cartridge ball caliber .22, Long Rifle) will be provided in Mk 1 Mod 0 steel small-arms ammunition boxes.

Boxes should be opened carefully, as they are to be used as long as they are serviceable.

An ammunition box or metal can should not be opened nor a metal liner broken until the ammunition is required for issue or use. Ammunition removed from airtight containers is apt to become unserviceable due to corrosion. This is especially applicable in damp climates.

Handling cartridges.—After a box of ammunition has been opened and cartridges issued, each man should take care of his own ammunition. The primer should be protected from blows by sharp instruments, as such a blow might explode the cartridge.

Ammunition should be protected from mud, sand, dirt, and water, and should be wiped off at once if it gets wet or dirty.

If verdigris (bluish-green deposit) or light corrosion form on cartridges, they should be wiped off with a dry wiping cloth. The use of abrasives is forbidden.

Ammunition should not be exposed to the direct rays of the sun for any length of time. If the powder is heated, it is likely to cause excessive pressure when fired and will affect the performance of the ammunition.

The use of oil or grease on small-arms cartridge cases is prohibited. Greasing or oiling cartridges used in machine guns and other automatic arms causes the collection of dust and other abrasives which are injurious. Grease or oil on the cases or on the walls of the chamber in nonautomatic weapons causes excessive and hazardous pressure on the bolt or breechblock and will result in damage. When there is oil on the cartridge case, there is no adhesion of the case to the chamber. When the case expands upon firing, the case slips back and the bolt receives a greater than normal rearward thrust.

Whenever cartridges are taken from cartons and loaded into belts or clips, the latter should be tagged or otherwise marked so that the ammunition may be identified as to lot number.

DEFECTIVE CARTRIDGES.—Cartridges having dents or scratches, cartridges with loose bullets, or otherwise defective rounds should not be fired. Lots having more than 5 percent of defective cartridges will be subjected to 100 percent inspection. Defective rounds will be culled out and serviceable cartridges repacked prior to issue. Defective cartridges will be considered as grade 3 ammunition.

The most common defects of small-arms ammunition that can be detected by visual examination are:

1. SEASON CRACKING.—A split or hair-line crack, usually in the neck of the cartridge case. Caused by internal and surface stresses set up during the tapering operations and the insertion of the bullet.

2. CORROSION.—As distinguished from true discoloration or blackening which alone does not affect the functioning of the ammunition.

3. MISCELLANEOUS.—In the manufacturing process a number of defects may occur if the metal is too thick or too thin, too hard or too soft or the manufacturing tools are worn or maladjusted. Some of these defects are loose bullets, case bulged, dented, burred or creased or head of case too thick or too thin. A condition called mouth pulldown may occur in which the mouth of the case is pulled out of shape or the neck of the case may be folded back on itself. Rough handling may in some cases cause similar defects.

STORAGE.—Small-arms ammunition is not an explosive hazard in storage, although under adverse conditions of storage it may become a fire hazard.

Small-arms ammunition should be stored and piled according to type and ammunition lot number. Extreme care must be exercised to prevent mixing of ammunition lots in one pile.

Whenever practicable, small-arms ammunition should be stored under cover. This applies particularly to tracer and shotgun ammunition. Tracer ammunition is subject to rapid deterioration if it becomes damp. It is possible that tracer ammunition may even ignite spontaneously. Shotgun shells, except for overseas shipment, are normally not packed in waterproof metal-lined boxes.

Should it become necessary to leave small-arms ammunition out-of-doors, the boxes should be raised on dunnage at least 6 inches from the ground and the pile covered with a double thickness of serviceable tarpaulin. The tarpaulin should be so positioned as to offer the maximum protection to the ammunition and to allow free circulation of air. Suitable trenches should be dug to prevent water from flowing under the pile.

Small-arms ammunition should be protected from extreme heat to avoid decomposition of the propellant powder. The combination of high temperature and damp atmosphere is particularly harmful to powder.

PRECAUTIONS IN FIRING AMMUNITION

No small-arms ammunition—other than blank ammunition, caliber .22 cartridges, and shotgun shells—will be fired until it has been positively identified by ammunition lot number and grade.

Before firing a weapon, it must be ascertained that the bore is free from any foreign matter such as cleaning patches, mud, sand, and snow.

When a bullet lodges in the bore of a rifle, pistol, or machine gun, it should be removed by the application of pressure from the muzzle end of the weapon.

Failure to Fire—Misfire and Hangfire.—A complete failure to fire is called a **misfire**, while a delay in discharge is termed a **hangfire**.

Because a misfire cannot be immediately distinguished from a hangfire, it is unsafe to open the breech of the weapon for at least 10 to 15 seconds when a misfire occurs. Another attempt to fire the round may be made if it is possible to cock the weapon WITHOUT opening the breech. If the round still will not fire, wait another 10 to 15 seconds and remove it.

Misfires may be caused from too light a blow of the firing pin, too thick metal of the primer cup, no primer pellet, no primer-pellet mixture between the primer cup and anvil, no anvil, vent hole, a worn firing-pin point, a firing pin off center, or a combination of these defects.

Hangfires normally do not occur as frequently as misfires. Hangfires may be caused by the presence of a damp powder charge; by a film of oil on the inside of the cartridge case; by a defective primer; and by other more unusual causes, such as those induced by very low temperatures. A hangfire is especially dangerous in all types of small arms.

"Cook-off" is the term applied to the ignition of a cartridge's propellant charge by the heat of the barrel in which it is chambered. It occurs most frequently in machine guns which have been fired in excessively long bursts, although it is possible to produce enough heat in rifles, carbines, or other small arms by prolonged rapid firing to cook-off a round left in the chamber.

In a caliber .50 aircraft machine gun, for instance, the maximum single burst which may be fired without danger to cook-off is 150 rounds. In general, the longer the burst fired, the longer the cooling-off period must be between bursts, to prevent not only cooking-off of the chambered round but damage to the barrel as well. If an overheating burst is fired, the gun should be cleared within 10 seconds after completion of the burst. If the gun cannot be cleared within 10 seconds, the round should be allowed to remain in the chamber at least 5 minutes, making sure the gun is pointed in a safe direction. If an attempt is made to clear the gun between the 10-second and 5-minute period, the extracted cartridge may explode outside the weapon, causing serious injury to personnel or equipment.

20-MM AMMUNITION

Components

A round of 20-mm ammunition consists of a projectile, primer, propelling charge, cartridge case, and (in certain rounds) a fuze, all assembled into a unit assembly. The cartridge case and propelling charge are basically the same as the calibers .30, .45, and .50, except that the 20-mm round is larger. A millimeter is equal to 0.039-inch; therefore, 20-mm guns have a bore of 0.78-inch.

PROJECTILE.—The projectile is that component which is expelled from the gun by the force of the propelling charge. Standard nomenclature permits use of only the term "projectile"; the term "shell" is improper.

A projectile's body is pointed at its forward end and is blunt at the after end. The part of the projectile that tapers from the pointed nose is called the OGIVE. Figure 5–10 shows the main parts of a projectile.

Aft of the ogive and encircling the projectile body is the highly finished BOURRELET. The bourrelet is slightly larger in diameter than the projectile body (but slightly smaller than the gun bore), and supports the forward end of the projectile in the gun bore. Note that some 20-mm projectiles do not have the bourrelet.

Toward the rear of the projectile is the ROTATING BAND, which is slightly larger in diameter than the bore of the gun. Its functions can be summarized as follows: (1) It keeps the projectile firmly seated in the gun bore; (2) it acts as a gas seal, preventing escape of powder gas around the projectile as it travels through the bore of the gun; and (3) it steadies and supports the after end of the projectile, and by engaging the rifling, causes the projectile to spin when fired.

FUZE.—Two types of fuzes are used in 20-mm ammunition. The Point Detonating (PD) Fuze M75 is provided with the high-explosive-incendiary round for the M3 gun, while the Mk 78 is used with the high-explosive round for the Mk 12 gun.

FUZE PD M75.—The M75 is a single-action type fuze, in-

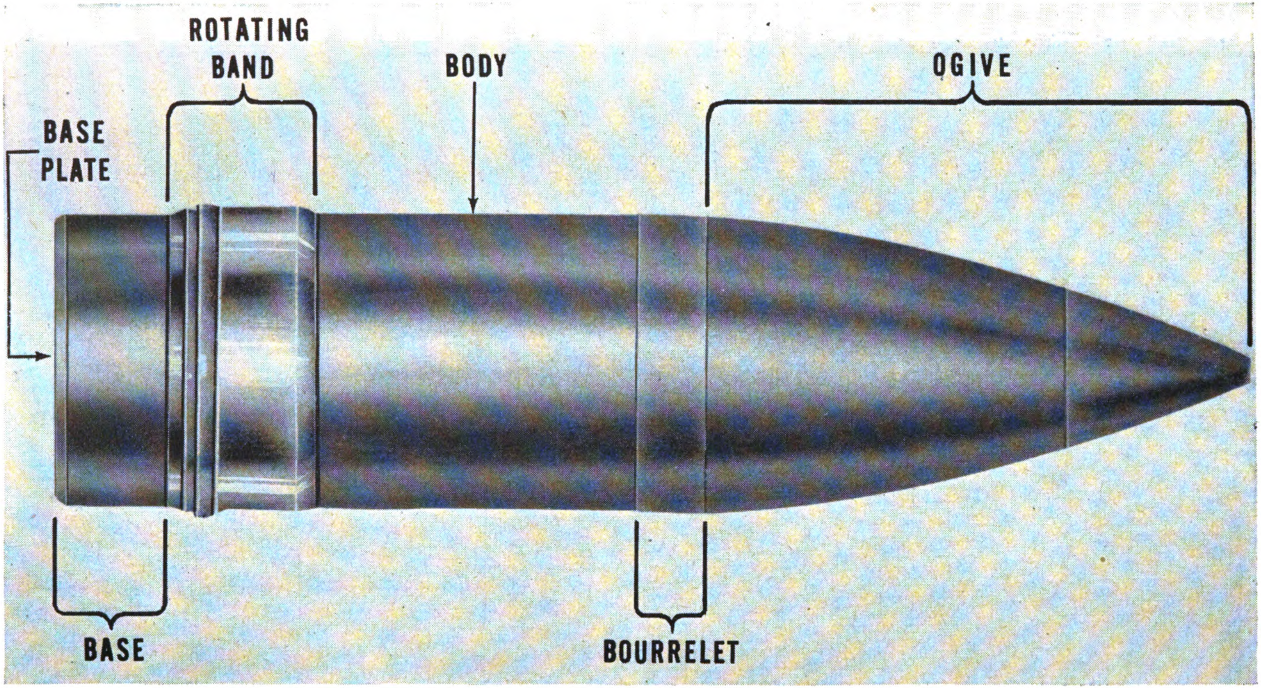


Figure 5–10.—Main parts of a projectile.

tended to function with instantaneous percussion action upon impact with light material surfaces. As figure 5–11 shows, the fuze is made up of two major parts, a body with an air space in the forward part of the fuze, and a magazine containing the explosive train. The magazine is screwed into the base of the body. The explosive train consists of a fulminate of mercury detonator, a relay charge of lead azide, and a booster charge. Since there is no interrupter, or other safety device, the fuze is considered nonboresafe.

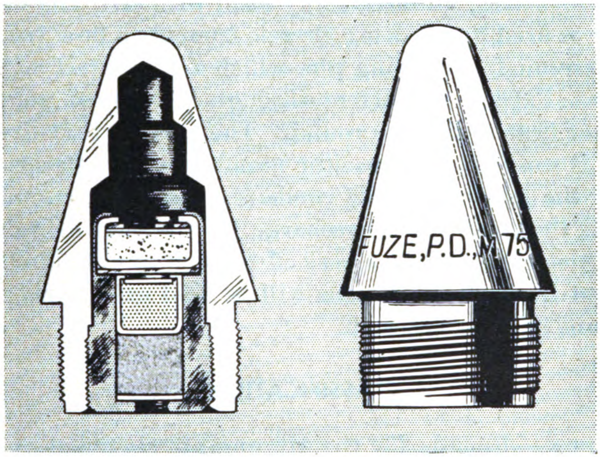


Figure 5–11.—Fuze PD M75.

The striker or firing pin usually found in point detonating fuzes is not present in the M75 fuze. When a round is fired, no action takes place until impact. Upon impact, the head is crushed. The set-forward force of the detonator charge (or pieces of metal from the body striking the detonator charge) initiates action of the detonator. Action of the detonator in turn initiates functioning of the booster cap or relay charge, which causes the booster charge to detonate. The booster action detonates the main charge in the round. The fuze requires no preparation for firing.

Fuze PD Mk 78.—The Mk 78, which is provided with the high-explosive round for use in the Mk 12 gun, is a point detonating fuze, armed by centrifugal force and acceleration (set back). It is boresafe for 24 inches from the muzzle, at which point the fuze becomes armed at a muzzle velocity of 2,800 feet per second.

PRIMER (percussion type).—Ammunition for the M3 gun is manufactured with the percussion type primer. The percussion type primer is fired by a blow from the firing pin on the primer cap in the same way that small-arms primers are fired.

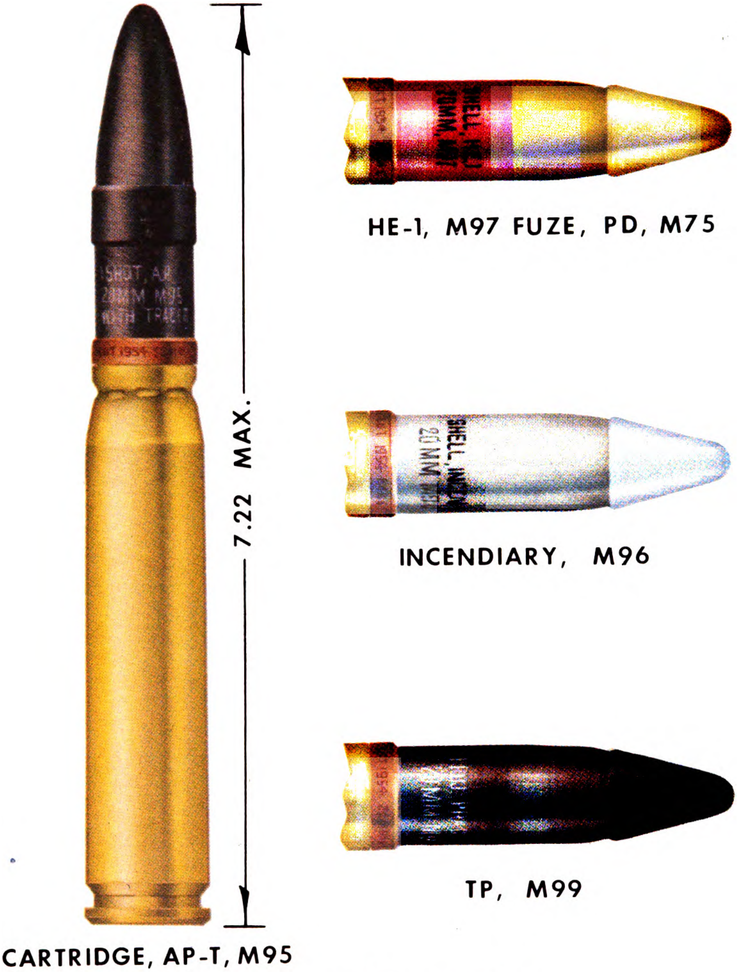
PRIMER (electric type).—Ammunition for the Mk 12 gun is provided with an electrically fired primer. The electric primer is fired by allowing electric current to flow from the firing circuit to the firing pin, which is in contact with the primer. Passage of current through the primer generates sufficient heat to fire the round. The current that fires the round is supplied by capacitor (condenser) discharge. Recoil of the gun breaks the condenser discharge circuit and permits the condenser to recharge for the next firing cycle.

The electric primer is a very effective means of timing gun fire, and from all indications will be used exclusively in 20-mm guns of future design.

CLASSIFICATION

M3 GUN.—Rounds for the M3 gun are classified as high-explosive-incendiary (HEI) M97, incendiary M96, armor-piercing with tracer (AP–T) M95, and target-practice (TP) M99. The HEI projectile contains both a high-explosive and incendiary filler. The incendiary projectile contains an incendiary filler only. The AP–T projectile is a solid shot, containing a tracer element for observation of fire; that is, for showing the gunner the path of the projectile in flight. The TP projectile is inert.

Ammunition for the M3 20-mm gun has a muzzle velocity of 2,800 feet per second, with the exception of the incendiary M96 which because of its lighter projectile has a muzzle velocity of 2,840 feet per second. The chamber pressure is 42,000 pounds per square inch. These four rounds have



HE-1, M97 FUZE, PD, M75

INCENDIARY, M96

TP, M99

CARTRIDGE, AP-T, M95

Figure 5-12.—20mm ammunition.

matched ballistics, and are approximately the same in shape, length (7.2 inches), and weight (0.57 pounds).

MK 12 GUN.—Rounds for the Mk 12 gun are classified as high-explosive-incendiary (HEI) Mk 12, armor-piercing-incendiary (API) EX 5, and target-practice (TP) Mk 11.

The ammunition for the 20-mm gun Mk 12 is also matched ballistically. It has a muzzle velocity of about 3,300 f. p. s. and develops a chamber pressure of 58,000 p. s. i.

IDENTIFICATION

In common with other types, 20-mm ammunition is identified by painting and markings. The projectiles of rounds for the M3 gun are painted as follows:

High-explosive-incendiary	Yellow ogive, red body.
Incendiary	Blue ogive, gray body.
Armor-piercing with tracer	Black.
Target-practice	Black.

The projectiles of rounds for the Mk 12 gun are painted as follows:

High-explosive	Red.
Armor-piercing-incendiary	No color.
Target-practice	Green.

The following identification markings are stenciled or stamped on the components of all rounds:

ON PROJECTILE (STENCILED).

Kind and type of projectile. (See fig. 5–12.)

Caliber and model designation.

ON PROJECTILE (STAMPED ON ROTATING BAND).

Lot number.

Year of manufacture.

Manufacturer's initials.

Caliber and model designation.

ON HEAD OF CARTRIDGE CASE (STENCILED).

Ammunition lot number.

Loader's initials.

The letters ELEC. (On electrically-fired primer only.)

ON HEAD OF CARTRIDGE CASE (STAMPED IN METAL).
Designation and caliber of case.
Manufacturer's initials or symbol.
Year of manufacture, in full.
ON FUZE (STAMPED IN METAL).
Model and designation of fuze.
Manufacturer's initials or symbol.
Loader's lot number.
Year of loading.

CARE AND HANDLING

Ammunition for the 20-mm automatic guns is packed in cartons in metal-lined wooden boxes or in metal containers in wooden boxes, and in Mk 1 Mod 0 steel boxes. Since explosives are adversely affected by moisture and high temperature, the following precautions should be observed:

Do not break moisture-resistant seals until ammunition is to be used.

Protect ammunition—particularly fuzes—from high temperatures, including the direct rays of the sun. More uniform firing is obtained if all the rounds are at the same temperature.

Handle ammunition with care at all times. The explosive elements in primers and fuzes are highly sensitive to shock and high temperature.

Do not attempt to disassemble any complete round or fuze.

The complete round should be freed of foreign matter such as sand, mud, or grease, just prior to loading into the magazine or belt. If it gets wet, it should be wiped dry at once.

Although the use of oil or grease on ammunition is generally prohibited, in the case of ammunition for the 20-mm gun M3, it is necessary to oil the cartridge case in order to prevent jamming. By means of a cloth dipped in and wrung out of light preservative lubricating oil, spread a light film of oil evenly over the body of the cartridge case just prior to insertion of the round into the magazine or belt. Extreme care should be taken to prevent oil from getting on the primer or joint at the mouth of the cartridge case.

For use in aircraft machine guns, ammunition must be assembled by means of metallic links into belts. These belts are assemblies of unit links, one for each cartridge. Figure 5–13 shows a single link and four caliber .50 cartridges assembled into a belt. When ammunition is assembled in metallic links it forms a flexible belt which can be made into any desired length. When firing, as each cartridge is extracted from the belt, one link falls free and is ejected from the gun into a chute. The chute either drops the link clear of the airplane or into a receptacle.

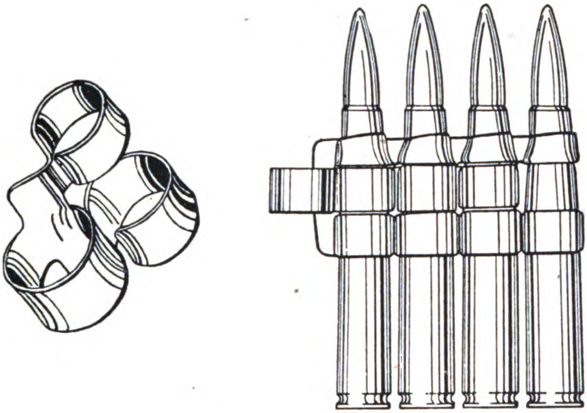


Figure 5—13.—Section of link belt and individual link.

Link-Delinking Machine, Cal. .50, M7

The Link-Delinking Machine M7 is a hand-operated device for linking or delinking caliber .50 ammunition. (See fig. 5–14.) The machine consists of a base, handle, slide (bar), and delinker (bar), and is operated as follows:

To delink ammunition, partly raise the handle and lay the belted ammunition on the base with the separating pins between the cartridges and the links against the pins. Then lower the handle until the delinker engages the extractor grooves in the cartridges, hold the delinker in position, and raise the handle. This will cause the delinker to move rearward and pull the cartridges from the links.

To link ammunition, properly assemble links and place on base adjacent to the **U**-shaped link stops, then place cartridges in the grooves of the base, and start them into the links. With delinker raised, lower the handle until the slide presses against the base of the cartridges, and forces them forward into the links. Move handle downward until slide is checked by the slide stops on the sides of the base. The cartridges will then be loaded to the correct depth in the

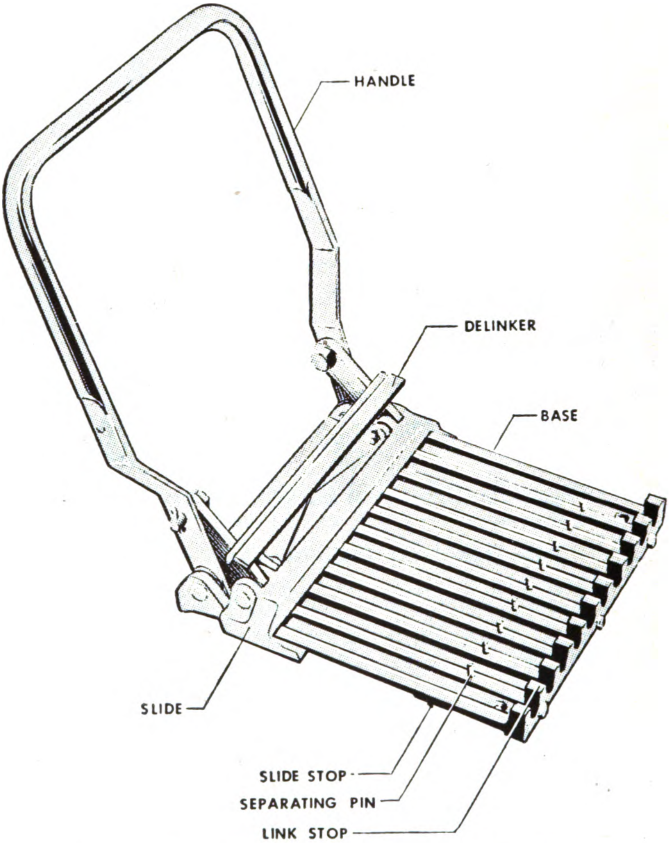


Figure 5–14.—Link-Delinking Machine, Cal. .50, M7.

links. Care should be taken to properly position that portion of the loaded belt that is adjacent to the section being loaded. Pivot pins should be cleaned and lubricated periodically to insure smooth action. Wipe dry of excess oil.

20-mm Link Loading Machine M16

Figure 5–15 shows an Army-type 20-mm Link Loading Machine M16 assembled for the linking operation. The official designation for this equipment is 20-mm Link Loading Machine (Army M16). This machine is a portable unit with carrying handles located on the sides and rear of the mounting frame. It is normally powered by a one-quarter-horsepower motor, but may be operated manually in the event of power failure. A variable diameter pulley on the motor permits adjustment of operating speeds.

This machine is designed to mechanically assemble 20-mm cartridges into metal clips to form a continuous belt of ammunition for use in 20-mm machine guns. Attachments are provided to convert this machine so that it will function as a delinker for the disassembly of an ammunition belt into its components. An adjustment is provided to allow use of either M3 or M10 type links in forming the belt. M10 links (also known as M8E1) are now issued to replace the M8 for service use.

Attachments and accessories for the link loading machine include a manual drive handcrank, those parts used only for linking operations, and those parts used only for delinking operations. The handcrank replaces the handwheel on the drive shaft for manual operation of the machine.

The attachments for linking operation include the ammunition tray, link chute, linking loading wheel guide, ammunition feed assembly, and two pushers.

Special attachments used only for delinking are the delinking loading wheel guide, loading wheel shield, and two ejectors.

Linking operation is performed by feeding cartridges and links into the machine by gravity. The cartridges in the ammunition tray are picked up by ammunition feed sprockets and carried around to the loading wheel. Links are gravity fed from the link chute into link-retaining sprockets in front of the loading wheel. Reciprocating pushers function to move the cartridges axially along the loading wheel into the links held in the link-retaining sprockets. The linking is performed in two stages, by pushers, as the loading wheel is rotated intermittently between strokes. A short pusher first contacts the base of the cartridge and moves it partially into the links. The pusher then retracts and the loading wheel rotates to align the cartridge base with the long pusher. The long pusher completes pushing the cartridge into the links while the short pusher simultaneously moves the next round into the succeeding pair of links.

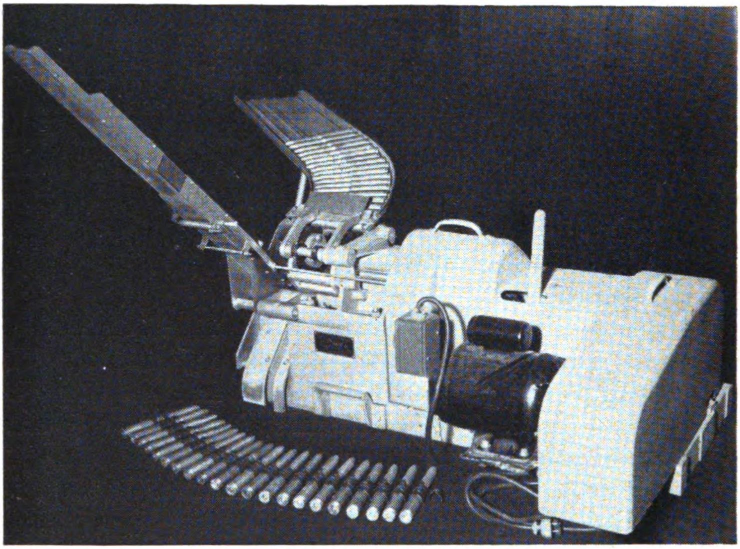


Figure 5–15.—20-mm Link Loading Machine M16.

The delinking process is virtually the reverse of the linking process. For delinking, the long pusher is replaced by a short ejector and the short pusher is replaced by a long ejector. Belted ammunition is fed over the loading wheel so that the links ride in the link-retaining sprockets. The long ejector first engages the extractor groove of the cartridge and partially pulls it from the links. The loading wheel then rotates to align the partially extracted cartridge with the short ejector which, as it reciprocates, completes pulling the cartridge from the links; at the same time, the long pusher partially extracts the succeeding cartridge.

When assembled for operation, the linker has the following characteristics:

Over-all dimensions:	
Length, inches	54⅝
Width, inches	47½
Height, inches	33⅝
Weight: pounds (including attachments)	300
Operating speeds:	
Powered linking, rounds per minute	85–150
Powered delinking	85–250
Manual operation (average)	60

Operation of Link Loading Machine M16

For continuous operation of the machine at or near its maximum production rate, a minimum of five men is required. Three men are required to feed the machine: an ammunition loader, a tracer ammunition loader, and a link loader. If only one type of ammunition is used, the tracer loader will not be needed. To maintain production and support the loaders, three additional men are required to open the boxes of ammunition and links, supply the loaders, and dispose of linked ammunition. Figure 5–16 is a plan view showing the position each loader should take around the linker, and the recommended locations of the cartridge and link containers. The ammunition loader should stand at the outboard end and to the rear of the ammunition tray. The tracer loader, when required, should take a position on the opposite side of the ammunition tray. The link loader should take a position in front of the outboard end of the link chute. Cartons should be supplied the link loader on pallets or carts, and should be placed at the end of the chute. A

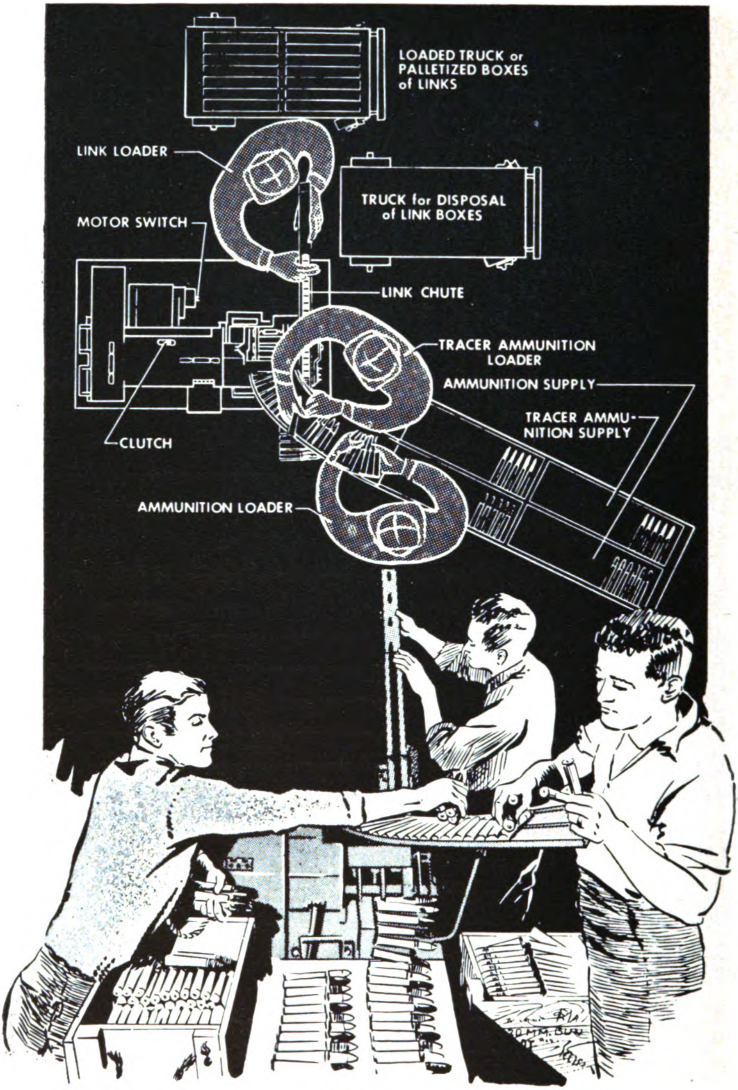


Figure 5–16.—Link loading machine—Personnel arrangement.

standby pallet or cart of packaged links should be available, so that the linker will not be forced to stop operation while a fresh supply of links is being moved into position. A wheel cart, or some other readily movable container, should be placed near the chute for rapid disposal of the empty cartons.

Because of the speed with which the machine must be fed, it is impractical to load the ammunition from ten-cartridge cartons. Accordingly, it is suggested that the man detailed to open the cartons place the cartridge in a suitable container, holding not more than 300 rounds, for ease of handling. For easy transfer to the ammunition tray, the cartridges should be placed in the container with all projectile tips pointing in the same direction. Containers of both types of ammunition should be placed parallel to the ammunition tray, with the cartridges pointing in the same direction as those in the tray. At least two containers should be used for each type of ammunition, so that each container, as emptied, may be replaced by a full one, with a minimum amount of effort and delay.

STARTING.—Before starting the machine, the main cover should be removed and the following precautions taken:

Manually operate the mechanism by rotating the handwheel in a counterclockwise direction, and at the same time, observe that the working parts function without interference. Also observe that the pushers of the reciprocating pusher mechanism are centrally located with respect to the grooves in the loading wheel assembly. Make any necessary adjustments in accordance with instructions contained in OP 1713, *20-mm Link Loading Machine M16.*

Disengage the clutch after the above precautions have been taken. Start the motor and then engage the clutch to see that the machine functions properly.

Do not attempt linking or delinking operations with main cover or guards removed.

Do not make speed change adjustments with the motor running. Stop motor, disengage clutch, and rotate pulleys by hand until belt adjusts to change of motor position.

LOADING.—In addition to the precautions stated above, the following precautions should be taken in connection with the loading of links and cartridges:

Insert links into the chute with their open sides upward and with all single loops either leading or trailing. Links inserted with their open sides downward would cause jamming of the machine; links with their single loops not pointing in the same direction would cause the belt to be broken.

Always insert cartridges into the ammunition tray with their projectile tips pointing toward the front of the machine. Failure to do this would result in a jammed machine and might prove hazardous to operating personnel.

In starting an empty machine, manually operate it with the handwheel until the first round joins a link and the linking process has begun.

Always keep the ammunition tray and link chute as nearly full as possible during operations. Stop the machine before the last few cartridges are out of the ammunition tray or before the links fall below the level of the lower vibrator hammer.

LINKING.—When setting up for linking operations, the following additional precautions should be observed:

Make certain that the loading wheel and feed spur gears are meshed in accordance with their index marks. Improper mating of these gears would result in misalignment of the grooves in the cartridge loading wheel and the feed wheel sprockets.

Inspect to see that there is proper connection of the vibrator rod to the lower vibrator socket.

Check vibrator cam follower for proper contact with cam on pusher crank.

Inspect connection between the pusher crank and pusher crank rod, making certain that the crank stud is seated in the hole marked LINKER.

Inspect pushers for proper assembly, with the short pusher assembled in the upper bushing.

Make sure that the link selector and vibrator assembly are adjusted for the type of link to be used.

DELINKING.—When setting up the machine for delinking operations, the following precautions should be observed:

Inspect connection between the pusher crank and pusher crank rod, making certain that the crank stud is seated in the hole marked DELINKER.

Assemble belted ammunition in the grooves of the loading wheel, with the open sides of the links upward.

Assemble the first cartridge of the belt in the highest groove in the ascending side of the loading wheel.

Make certain that the link selector and vibrator assembly are adjusted for the type of link connecting the rounds.

Inspect ejectors for proper assembly, with the long ejector assembled in the upper bushing.

SHUTTING DOWN.—Upon completion of operations, observe the following precautions:

Clear the machine of all remaining cartridges and links. See that the feed wheel, loading wheel, ammunition tray, and link chute are empty.

Disengage the clutch and disconnect the motor cable from the outlet socket.

SPECIAL AMMUNITION

Cartridges for Use in the Douglas Bomb Ejector

The 1-INCH CARTRIDGE MK 1 MOD 2 (BOMB EJECTOR) was the first cartridge released for service use in the Douglas Bomb Ejector, which is mounted in certain attack aircraft. The cartridge provides power to displace the bomb or other load to sufficiently clear the propeller when the aircraft is in a diving attitude. At the time the Mk 1 cartridge was designed, it was anticipated that only loads weighing between 500 and 2,000 pounds would be carried on this station.

The 1-INCH CARTRIDGE MK 1 AND MODS can be used when carrying loads on the bomb ejector which weigh between 325 pounds and 2,000 pounds inclusive. Loads in this weight and size range will safely clear the propeller when the aircraft is in diving attitudes up to 90°, except that when carrying the 2,000-pound GP Bomb AN–M66A2, the diving attitude should not exceed 80°. Aircraft torpedoes can be launched satisfactorily in level flight when using this cartridge.

The 1-inch Cartridge Mk 1 and Mods CANNOT be used when carrying the following on the bomb ejector:

1. Loads weighing less than 325 pounds. The energy provided by the cartridge is in excess of the amount required to displace the lighter loads clear of the propeller, and the ejector mechanism is damaged.

2. The Mine Mk 34, which would be damaged by the force exerted by the bomb ejector foot. The Mk 34 mine is an advanced underwater weapon (AUW) and because of its security classification has not been discussed in this text.

The 1-INCH CARTRIDGE MK 2 MOD 0 has been designed to correct the above deficiencies. The Mk 2 cartridge is shorter than the Mk 1 and contains a reduced charge. It is intended for use when carrying such loads as the 100-pound Water-Sand-Filled Practice Bomb Mk 15, the 250-pound GP Bomb AN–M57A1, and the Mine Mk 34. The latter should be launched only in level flight. Loads no larger in size and weight than the AN–M57A1 bomb will safely clear the propeller in dives up to 90°. Use of the Mk 2 cartridge with loads which weigh less than the water-only filled Practice Bomb Mk 15 (58 pounds) will damage the bomb ejector.

Engine starter cartridges SHOULD NOT be used in the Douglas Bomb Ejector. The design of these cartridges incorporates an inherent excessive and inconsistent lag between completion of the firing circuit and functioning of the cartridge. This lag is unimportant when cartridges are used in engine starters, but has an adverse effect on accuracy of bomb placement when used in the bomb ejector.

Both Mk 1 and Mk 2 cartridges have electrically fired primers.

Personnel Ejection Catapult Cartridge Mk 1 Mod 0

The PERSONNEL EJECTION CATAPULT CARTRIDGE MK 1 MOD 0 is designed for use in the personnel catapults which are a part of ejection seat installations. The cartridge has a hermetically sealed aluminum case with an ignition charge of 100 grains of black powder, and a propellant charge of 128 grams of smokeless powder. It is percussion fired, and is designed to eject the seat with an acceleration of 18G.

The cartridges are packed three to a hermetically sealed tear strip metal can, and four such cans to a metal container. Cartridges are to be handled and stored as small-arms ammunition. Ejection seats with cartridges installed should be shielded from direct sun, steam pipes, or other sources of heat when removed from the aircraft.

Instructions covering the installation of this cartridge in ejection seat catapults are contained in the specific Handbook of Maintenance Instructions for each type of aircraft using ejection seats. It is to be emphasized that the firing mechanism of the catapult must be cocked and the catapult safety pin must be secured before screwing this mechanism back in place. In the uncocked position the firing pin will strike the cartridge primer when the firing mechanism is screwed down.

The SERVICE life of the cartridge is established by the Bureau of Ordnance. This service life begins at the time the container is opened, regardless of whether the cartridge is installed in a plane or merely stored in the open box.

A STORAGE life of 3 years has been established on any cartridge LOT, after which the lot must be installed in planes or the lot reaccepted on the basis of tests of representative samples. This storage life may be extended by the Bureau of Ordnance if experience shows it to be too conservative.

When a container of 3 cartridges is opened, the date of opening the can and the expiration date shall be stenciled in indelible ink on the cartridge cases of all 3 cartridges as follows:

Container opened ______ day ______ month ______ year.
Service life expires ______ day ______ month ______ year.

On expiration of the cartridge service life, as determined by BuOrd, the cartridge must be removed and disposed of, and a fresh cartridge installed.

Prior to installation in an aircraft, the type and bureau number of the plane in which the cartridge is to be installed shall be stenciled on the cartridge case. No cartridge shall be removed from one aircraft and used in another.

When a cartridge is installed in an aircraft, an entry to indicate the following data must be made in the aircraft log in the section designated "Replacement of Major Components and Accessories":

1. Date of installation.
2. Lot number of the cartridge.
3. Cartridge expiration date.

Unserviceable, overage, or replaced cartridges shall be disposed of ashore as directed by the Bureau of Ordnance. Activities afloat may dump such cartridges at sea in accordance with current BuOrd Instructions.

QUIZ

1. Name the four components of a small-arms cartridge.
2. What is meant by the term "boattailed"?
3. What is the purpose of the primer?
4. Cartridges are identified as to size by the (1) __________, and shotgun shells are identified as to size by the (2) __________.
5. Cartridges are identified as to type by the __________ of the bullet tip.
6. Why are grades assigned to each lot of ammunition?
7. All grade 3 ammunition is to be considered as __________ ammunition.
8. In cartridge nomenclature, what do the letters API mean?
9. Name the five component parts of a round of 20-mm HEI ammunition.
10. Why is 20-mm ammunition not considered as small-arms ammunition?
11. What are the three functions of the rotating band on the projectile?
12. 20-mm ammunition is manufactured with what two types of primers?
13. Why must the Fuze PD M75 be considered nonboresafe?

14. Name the component parts of the explosive train in the Fuze PD M75.

15. For identification purposes, what information is stenciled on the projectile of 20-mm ammunition?

CHAPTER 6

ROCKETS AND JATO

The use of rockets in warfare is not a recent development; in the thirteenth century they were used by the Chinese in the defense of Peiping against the Mongols. During the first two decades of the nineteenth century an Englishman, Sir William Congreve, developed artillery rockets that weighed up to 24 pounds and had a range of about 2 miles, and the British used these during the Napoleonic Wars and the War of 1812.

The revolutionary gun designs later in the nineteenth century, along with the development of smokeless powder, partially eclipsed the further development of rockets as a military weapon until World War II. During World War I, for example, rockets were largely restricted to such auxiliary jobs as signaling, and carrying lines in sea-rescue work; their only aerial offensive use consisted of tying them to the struts of French and Russian airplanes and shooting them into German observation balloons.

Beginning in the latter part of 1941, the armed forces of Germany, Great Britain, and Russia came out with military applications of the rocket principle, all having worked on it for several years before the outbreak of war. Rockets were still much less accurate than guns, but they made up for this shortcoming by the fact that they had no recoil and could be fired from a simple light launcher instead of a heavy gun. They could be used where absence of weight was desirable or a great volume of fire was more important than accuracy.

By 1941 the United States had also embarked on a rocket program and began rocket operations in the North African campaign of World War II with the Rocket Launcher M1, otherwise known as the bazooka. The year 1943 saw the first aircraft rockets used and by the end of the war a variety of aircraft rockets were in combat use, ranging in size from the 3.5-inch rocket to the 11.75-inch "Tiny Tim."

A rocket is a self-propelled projectile or vehicle which burns solid or liquid fuel in a combustion chamber. This combustion chamber is generally a tube, closed at the front end and with a restricted nozzle on the other. The fuel is usually solid in unguided rockets and liquid in the large guided missiles.

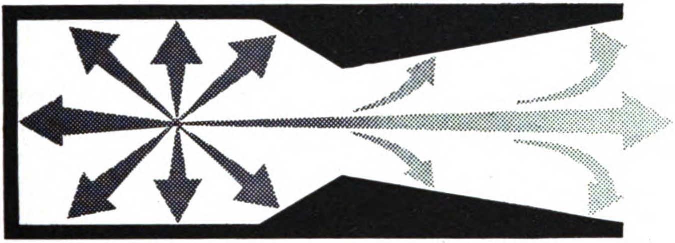


Figure 6–1.—Forces acting in a rocket motor.

As the fuel burns, large quantities of gas are produced, resulting in high pressures within the tube. Force is exerted in all directions by the pressure; pressure against the sides cancels itself, but pressure against the closed end of the tube has no counter effect from the opposite end, which is partially open. Thus there is thrust against the closed end and the rocket moves in that direction; the thrust produced here is roughly 67 percent of the total. The remaining 33 percent is produced as the exhaust gases rush out through the venturi tube (see fig. 6–1). Due to the shape of the venturi, the velocity of the escaping gas is increased as it travels through the restricted opening, with a corresponding decrease in pressure. As soon as the gas passes the opening, it expands and pushes against the sloped sides of the venturi outlet, resulting in additional thrust against the rocket.

JATO is another application of the rocket principle. The term JATO is an abbreviation of "Jet Assisted Takeoff"; strictly speaking, the nomenclature is incorrect in that a JATO unit is actually a rocket and not a jet engine, as the word "jet" is used in aviation today. JATO will be discussed in the latter part of this chapter.

Military rockets may be classified, according to the means of control, into two general types: (1) the unguided rocket, the course of which cannot be altered once launched; and (2) the guided missile. This text does not deal with the guided missile.

AIRCRAFT ROCKETS

Until recently, airplanes had two weapons: relatively small caliber guns and bombs. Bombs are not wholly satisfactory for some purposes because they lack penetrating power unless dropped from great heights. In addition, it is relatively difficult to aim a bomb because its path in falling describes a curve rather than a straight line. Aircraft guns are relatively easy to aim because their projectiles travel in a flat curve; however, these guns must be comparatively small because aircraft structures cannot stand the recoil of larger weapons. The 75-mm gun has been mounted in aircraft, but the recoil problems have been difficult to solve.

On the other hand, the SMALLEST air-to-ground rocket used today, the 2.75-inch rocket, has as much or more effect on impact with a target than a projectile from an airborne 75-mm gun with all its weight and recoil. The 2.75 Folding Fin Aircraft Rocket presently in service is primarily an air-to-air rocket. Air-to-ground utilization of this rocket with a different type of head is contemplated. The larger rockets have proportionally greater destructive effect and a fighter plane's salvo of 5-inch High Velocity Aircraft Rockets (HVAR) is the equivalent of a destroyer's salvo power. It is true that a rocket will not attain quite as much velocity as a gun projectile, but the rocket can be delivered to any target within combat range of the carrying aircraft and fired from a great variety of angles and altitudes.

Since the airborne rocket is usually launched at close range—about 1,000 yards—its accuracy as a propelled projectile is much higher than that of a free-falling bomb dropped from high altitude. The rocket's velocity during flight is much higher than that of a bomb, and mobile land and sea targets have practically no time in which to take evasive action.

Aircraft rockets are at present stabilized by means of fins, either fixed or folding, but spin-stabilized aircraft rockets are under development.

Standard rocket terminology has been agreed upon for use by all branches of the Armed Forces. In accordance with the agreement, the Bureau of Ordnance has adopted the following terminology:

1. HEAD.—That part which is functionally similar to a projectile and which contains the high-explosive, chemical or pyrotechnic filler. The caliber of the complete rocket is determined by the outside diameter of the head.

2. MOTOR.—The motor tube, nozzle or nozzles, and propellant grain and igniter.

3. FIN OR FIN ASSEMBLY.—Stabilizing components of a nonrotation rocket. Figure 6–2 shows the separated head, motor, and fin assembly of an 11.75-inch aircraft rocket.

4. CABLE.—Connection between the igniter and the electrical plug.

5. PLUG.—Electrical connection to the aircraft's rocket firing system. The plug fits into a socket on the launcher or aircraft structure.

6. ELECTRICAL CONNECTOR.—An assembly consisting of the cable, plug, and usually the nozzle closure disk.

7. FUZE.—The device in the nose and/or base of the rocket head which detonates or expels the charge.

8. LUG BANDS.—Bands which are attached to the motor tube and which are equipped with fittings to suspend the rocket from the rail or post launchers. When the fittings are attached directly to the tube, they are referred to as lugs. BUTTON lugs are used on rail launchers, while TUNNEL and BUTTON lugs are used on most post or pylon launchers. The after sus-

pension band, when used, sometimes acts as a forward fin stop and prevents the fins from turning.

A complete round of rocket ammunition is the rocket assembled with all its components, ready for service use. The designations for complete rounds are determined by combining descriptive terms in the following sequence:

1. Caliber.
2. "Rocket."
3. Mark and Mod.
4. Parenthetical phrase including type of craft from which launched, such as "Aircraft" or "Surface," followed by the designation "Practice" or "Dummy," if applicable, or by designation of the head type. This may be High-Capacity, Common, General-Purpose, and so on, including "SS" for spin-stabilized rockets.

The following is an example of a typical round designation: 11.75-INCH ROCKET MK 3 MOD 0 (AIRCRAFT COMMON).

Note that the individual components of a complete round will have their own Marks and Mods, while the complete round may have a different designation. Thus the 11.75-inch Rocket Mk 3 Mod 0 (Aircraft Common) is the designation for a complete round which uses a Mk 2 Mod 0 head and a Mk 1 Mod 1 motor.

It should also be noted that the velocities given elsewhere in this chapter apply to a rocket if fired from a stationary launcher. When fired in the air, the speed of the firing aircraft must be added to the speed of the rocket in order to obtain true velocity.

ROCKET COMPONENTS

Heads

The rocket head varies with the type of rocket and the target to be attacked. Targets such as submarines, tanks, or light vessels may call for solid steel heads or explosive armor-piercing heads. Pillboxes, shipping, or gun emplacements may require high-explosive heads filled with TNT, or similar

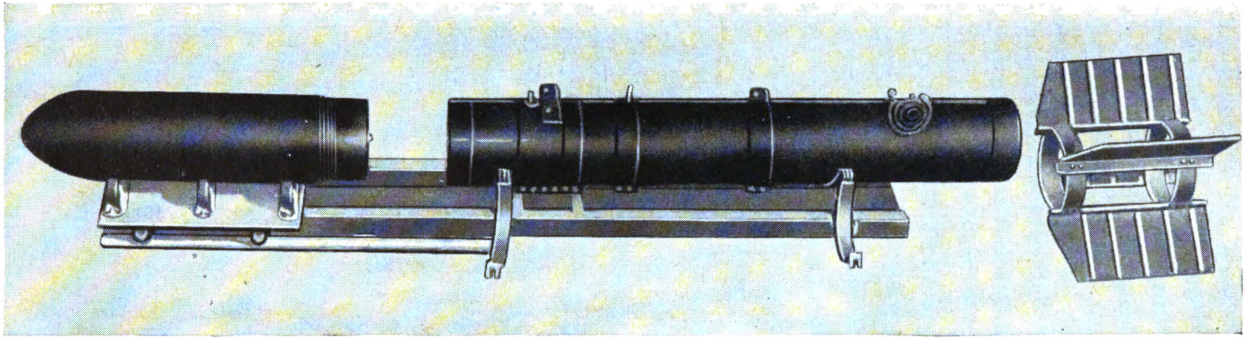


Figure 6–2.—Head, motor, and fin assembly of 11.75-inch Tiny Tim.

explosive, and equipped with instantaneous nose fuzes, delayed-action base fuzes, or both. (See figs. 6–3 and 6–4.)

The heads used in aircraft rockets are defined as follows for all the United States Services:

GENERAL-PURPOSE (GP).—Medium-walled heads containing less than 30 percent by weight of explosive. These heads have good blast effect and good penetration against light armor. Nose fuzes, base fuzes, or both are used.

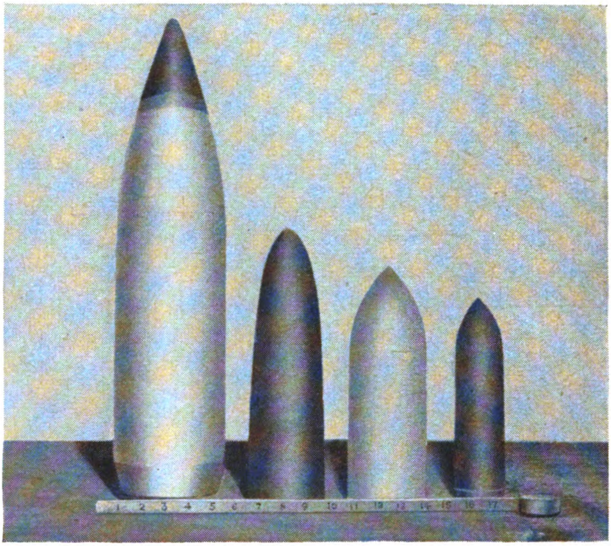


Figure 6–3.—Types of rocket heads.

SMOKE HEADS.—These heads are loaded with chemical agents which are primarily intended to produce smoke for spotting purposes.

FLARE HEADS.—Flare heads contain a pyrotechnic flare element attached to a small parachute, together with a small ejection charge. In earlier types, a fuze ignites a length of time fuze which in turn ignites the ejection charge. The ejection charge ignites and expels the flare, which is suspended from its parachute during descent. Later types of flare heads will use a mechanical time fuze.

Practice heads.—These heads are intended for use with live-loaded service motors for training in rocket firing or testing fuzes and motors, or with inert motors, for assembly as dummy rounds. The service heads used in practice rounds closely approximate the loaded service heads in shape and weight and generally have provision for installation of service fuzes. When a filler is required for weight, plaster or similar inert material is used. The special heads intended for use with the subcaliber rocket motors generally consist of a 1-piece steel or die casting and contain neither filling nor fuzes. Later types of special heads may be fitted with a mixture which will emit a smoke puff on impact, thus indicating the location of the hit.

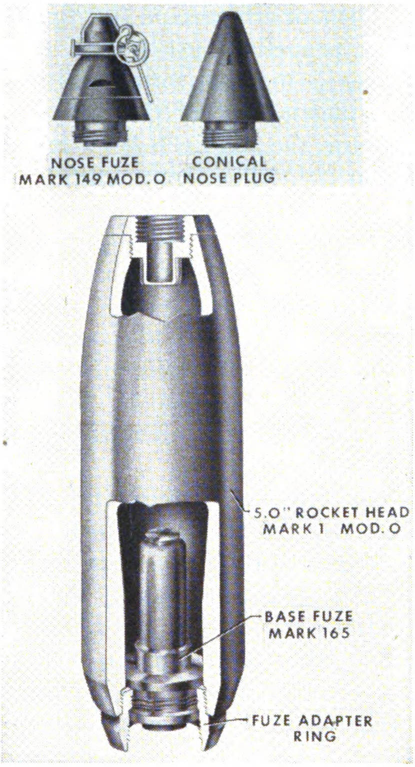


Figure 6–4.—Rocket head with nose and base fuzes.

HEAT HEADS.—High Explosive Anti-Tank. These heads are intended for use against armored targets. They contain a cone which produces a shape charge effect and will penetrate light armor.

Motors

The rocket motor is a seamless steel or aluminum tube largely filled with ballistite or SPCG, double-base propellants designed to burn at a slower rate than gunpowder and to generate a great volume of gas. In all except 11.75-inch aircraft rockets, this propellant is a single grain. In subcaliber training rockets the grain is in cylindrical form with longitudinal channels for the escaping gas, while in most service rocket motors, such as the 3.25-inch and 5-inch, the grain is in cruciform, or cross shape (see fig. 6–5). A recent development is a propellant grain with a star-perforated cross section to provide more uniform burning characteristics.

Following is a description of the component parts of a typical rocket motor, the 3.25-inch Mk 7 and Mods:

FRONT SHIPPING CAP.—The front shipping cap is screwed onto the front end of the motor tube. It protects the threads on the front end of the motor and seals the front end from moisture and foreign matter during shipment and storage.

CARDBOARD SPACER AND FIBER DISKS.—In the front end of the motor are several fiber disks and a cardboard tube used to fill the space remaining in the tube after the other components of the motor have been loaded. When the head is assembled to the motor, these disks and the spacer SHOULD NOT be removed.

FELT PAD.—The igniter, located behind the felt pad, is protected from shocks by the pad, which also takes up any changes in the length of the propellant grain due to expansion. The felt pad is held in place by the fiber disks which are cemented in place in the tube.

IGNITER.—The igniter in this motor consists of a plastic case containing black powder and an electric squib. The squib is a fine bridge wire connected across copper lead wires, and when current is sent through the squib, it becomes very hot, thus igniting the black powder which in turn ignites the

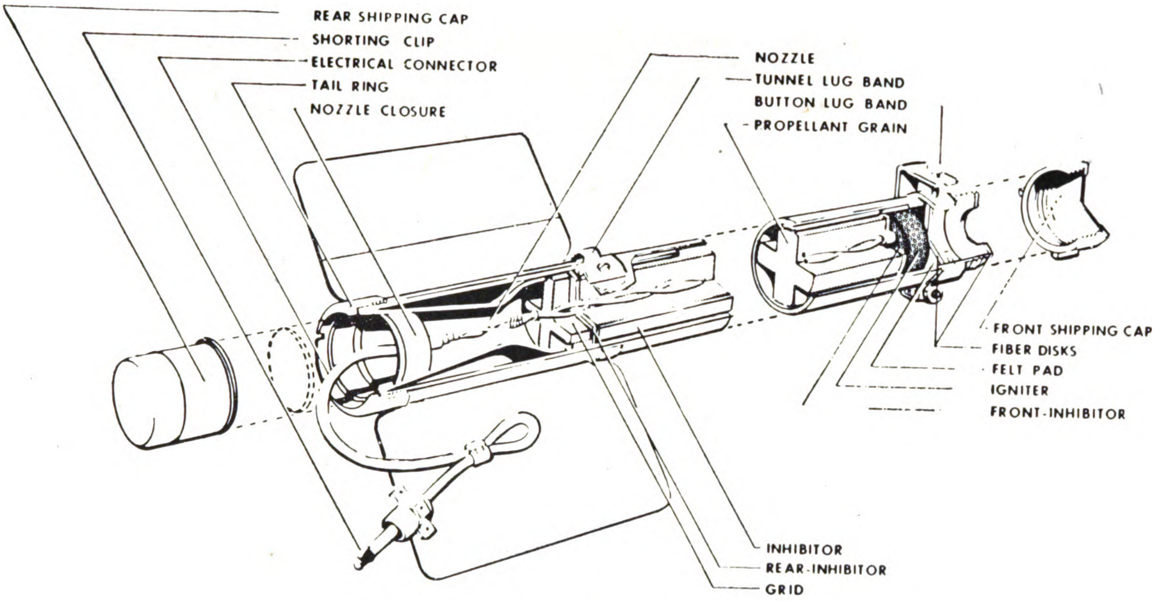


Figure 6–5.—Details of the 3.25-inch rocket motor.

propellant. The leads to the squib pass through the motor tube to the nozzle where they are connected to the electrical connector used in firing the rocket. The minimum amount of electricity required to ignite the igniter is only ¼ volt and ½ ampere.

The igniters used in the 5-inch HVAR motors are metal-cased black powder.

FRONT INHIBITOR.—The inhibitor is made of plastic material and is cemented to the front end of the propellant grain. It aids in controlling the burning area of the propellant, thereby controlling the pressure which is developed.

PROPELLANT GRAIN.—The propellant is a single grain of ballistite shaped in the form of a cross. Inhibitor strips, cemented to the grain, control the burning area of the grain and hence the pressure developed within the motor tube. The burning time of the grain varies from 0.3 to 1.75 seconds, depending on temperature. A cold motor will burn a longer time with less pressure than a hot motor, although both will attain the same ultimate velocity. A motor which is heated above the safe limit is likely to produce gas faster than it can be expelled through the nozzle, and an explosion results. For maximum safety and uniform performance, all rounds should be stored in temperature-controlled magazines whenever possible.

The gases produced by the burning of the grain are expelled through the nozzle or nozzles at nearly 7,000 feet per second and at temperatures at the throat of around 5,000° F.

REAR INHIBITOR.—This inhibitor is also made of plastic material and is cemented to the rear of the grain, thus separating the grain from the grid. Pins on the grid fit through holes in the inhibitor into recesses in the end of the grain.

GRID.—This is a steel support for the propellant grain having a cross section similar to that of the grain. The grid, rear inhibitor, and propellant grain are prevented from rotating independently by their interlocking construction. The grid keeps the grain from moving toward the rear when ignited, where it might clog the nozzle, and prevent the gases from escaping, and thus cause the motor tube to burst.

NOZZLE.—The nozzle is a steel venturi through which the gases flow. A motor may have from 1 to as many as 25, as is the case in the 11.75-inch Tiny Tim.

NOZZLE CLOSURE.—The nozzle is sealed by the nozzle closure, a plastic cup which fits inside the nozzle. It provides an airtight and moisture proof seal for the motor. The electrical connector, commonly called the pigtail, is crimped and sealed in place in the nozzle closure.

ELECTRICAL CONNECTOR (PIGTAIL).—The electrical connector is an electrical cable that terminates in a male plug for plugging into the receptacle of a launcher; in shipment it is coiled and placed in the nozzle and enclosed by the rear shipping cap. The plug of earlier Navy rockets was the two-pin type, and some launchers still have a two-pin receptacle to accommodate them. Navy rockets now use the Air Force-type plug, which is a single pin, jack-plug type. The shank provides ground contact while the insulated tip provides live contact. A Type B adapter is installed in the two-pin launcher receptacle to permit use of the single pin. A shorting clip on the plug shorts out any stray or static electricity in the igniter circuit.

REAR SHIPPING CAP.—This is a metal cup which protects the electrical connector during shipment and storage and is held in place by the tail ring. The cap is removed when the rocket is assembled. Both front and rear shipping caps will blow out if the motor is accidentally ignited, so that the rocket motor will be nonpropulsive and will be a fire hazard only.

TAIL RING.—The tail ring holds the rear shipping cap in place and also holds the fin assembly when assembled to the motor.

Each rocket motor is marked with two temperatures defining the range within which it is safe to fire the rocket. An attempt to fire a rocket, the temperature of which is less than the lower temperature prescribed, will result in spasmodic or partial burning with a very short travel. The result of firing a rocket which is too hot has already been mentioned.

Lug Bands

Lug bands are clamped securely around the rocket motor body fore and aft. A "button" lug band (see fig. 6–5) is located forward while a "tunnel" (or loop) lug band is located aft, although in some installations both bands are of the button type. The after lug band serves also to lock the tail fins and prevent their turning. Loading the rocket consists merely of slipping the button and tunnel into the bottom of the launcher, where a trigger latch locks the rocket in position until tripped by the impulse from the pilot's firing button.

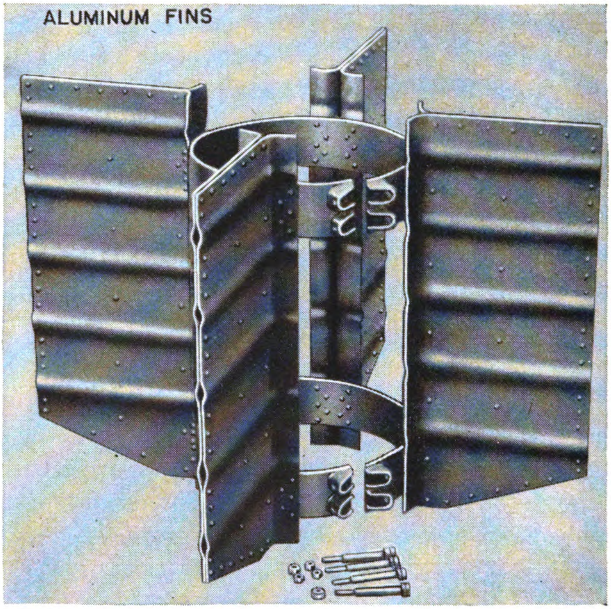


Figure 6–6.—Rocket stabilizing fins.

Fins

The fins, or stabilizing tail for 3.5-inch rockets and above, consist of a separate unit which is attached when the rocket is being assembled. The fins are either secured in place by the tail ring, a spring latch, or the fin assembly is clamped to the motor tube.

The tail stabilizes the rocket in the line of flight, thus preventing yawing and skidding. It corresponds to the tail of a bomb and is similar in design. (See fig. 6–6.)

A new development is the folding-fin tail. In this type tail the fins fold into or behind the rocket. When the rocket is launched, these fins are designed to fly out into a locked position. Folding fins are used on one of the newest rockets in service, the 2.75-inch air-to-air rocket, or "Mighty Mouse."

Fuzes

The nose and base fuzes used with aircraft rockets are of various types and, like rocket heads, are designed and selected for the required service and for the type of rocket to be detonated. Fuzes specifically designed for use in rockets are assigned numbers in the "100" series.

The nose fuze is screwed into the forward end of the head during assembly of the rocket. Impact nose fuzes require air travel to arm, and full arming is delayed until acceleration from the motor has ceased. Impact nose fuzes generally have instantaneous action.

All base fuzes come already installed in the base of the head and require no adjustment when the rocket is assembled or loaded on the plane. NO ATTEMPT SHOULD EVER BE MADE TO REMOVE A BASE FUZE. Base fuzes usually incorporate a delay of 0.015 or 0.020 second and are armed by pressure from the burning propellant and the forces of inertia.

Firing of a rocket fuze may be by impact, by time, or by radio proximity; the majority of fuzes currently used are of the impact-firing type. Equipping a rocket with both nose and base fuzes permits selective fuze action when the rocket is launched.

The pilot may leave the nose fuze safe when the rocket is launched, thereby causing the arming wire to be retained by the fuze. This prevents the nose cap over the impeller from flying off, the impeller does not turn, and the fuze remains unarmed. Thus the base fuze detonates with its predetermined delay after penetrating any target that offers sufficient resistance. If, however, the pilot decides that instantaneous detonation is desirable, he fires the rocket so that the nose fuze is armed and the fuze detonates immediately on impact.

NOSE FUZE MK 149 MOD 0.—The Mk 149 Mod 0 (fig. 6–7) is a typical air-arming, impact-firing nose fuze designed for use with 3.5-inch and 5-inch forward-firing aircraft rockets. The fuze body fits directly into the fuze seat liner in the nose of the rocket head.

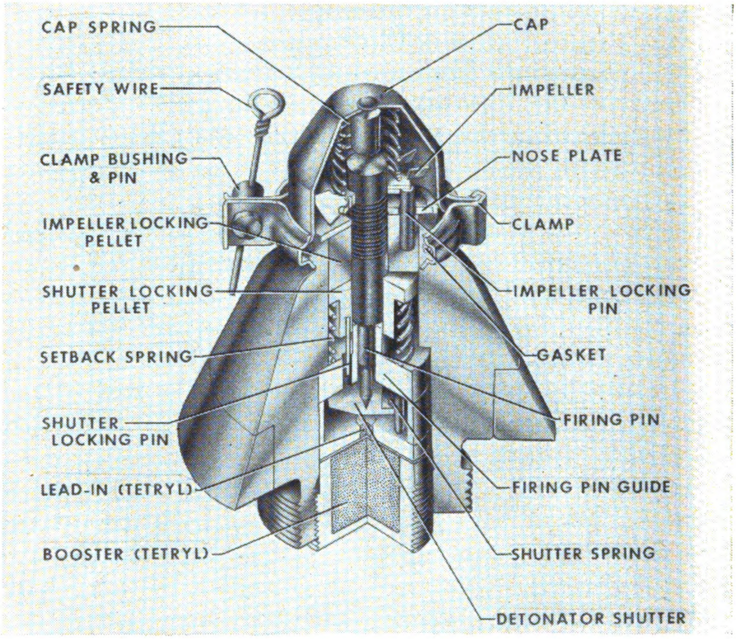


Figure 6–7.—Cutaway view of the Nose Fuze Mk 149 Mod 0.

In the unarmed position, the firing pin is screwed down alongside the detonator shutter, holding it in a safe position. The impeller is attached to the firing pin and is prevented from turning by the impeller locking pin which is attached to the impeller locking pellet. The cap on the nose of the fuze is held tightly in place on the gasket by a clamp assembly held together by a safety wire, or by an arming wire when the round is loaded on a launcher and ready to fire. This cap prevents exposure of the fuze to the weather and is removed only when the rocket is fired with nose fuze armed. A cap spring located under the cap bears on the top of the impeller, preventing it from turning as long as the cap is secured by the safety or arming wire. When an assembled round is loaded on the launcher, the arming wire is first inserted in a hole provided next to the safety wire in the clamp-pin and bushing assembly, after which the safety wire is removed. THIS ORDER MUST NOT BE REVERSED OR THE CAP WILL FLY OFF, EXPOSING THE IMPELLER.

When the round is fired, the arming wire pulls free, releasing the clamp assembly and allowing the cap spring to throw off the cap, thus exposing the impeller. At the same time, acceleration inertia forces the impeller locking pellet and pin backward, releasing the impeller. The same force moves the detonator shutter locking pellet and pin back, and as long as acceleration continues, the shutter is held locked by the locking pin. The impeller turns outward in a clockwise direction and after about eight turns the firing pin is clear of the detonator shutter. When acceleration ceases, the shutter locking pin is withdrawn by the action of the setback spring on the shutter locking pellet, and the detonator shutter is swung into the armed position by the action of the shutter spring, provided the firing pin has by this time advanced sufficiently to clear the detonator shutter. The shutter is locked in the armed position by a detent engaging in a hole in the firing pin guide. The firing pin jams and stops turning when the end of the threads reach the nose plate. Upon impact, the firing pin shears the threads in the nose plate and is driven into the detonator, thus setting off the explosive train.

Nose Fuze Mk 149 Mod 0 fires at impact angles as low as 5° to 10° for water, and for land targets which allow slight penetration. On hard targets it fires at impact angles of not less than 20° to 25°.

Since the shutter is held in the safe position by the shutter locking pin during acceleration, arming will not occur until about 0.1 second after acceleration ceases. Therefore, the arming distance of the fuze will vary from 200 to 800 feet, depending upon initial propellant temperature at which the round is fired and whether the fuze is in a 3.5-inch or 5-inch rocket. The shorter distance corresponds to a temperature of 130° F. and the longer distance to 0° F.

Nose Fuze Mk 149 Mod 0 is safe as long as the cap and clamp on the nose are held in place by the safety wire or arming wire. If the cap and clamp assembly comes off accidentally, the fuze is still safe as long as the arming impeller is locked by the locking pin.

Caution: If the arming impeller is free of the locking pin so it can rotate, the fuze is unsafe and proper disposition should be made of it. If the fuze is completely armed, the arming impeller extends one-half inch from the nose plate. Do not attempt to screw the impeller back in; to do so may detonate the fuze as well as the rocket head, if assembled.

NOSE FUZE MK 155 MOD 0.—The Mk 155 Mod 0 nose fuze is identical to the Mk 149 Mod 0 except that it incorporates a burster tube 3/8 inch in diameter and approximately 14 inches long in lieu of a booster charge. The burster charge is approximately 65 grams of tetryl, and the fuze is used in 3.5-inch rocket heads filled with FS smoke mixture or PWP (plasticized white phosphorus). The fuze functions on impact and the tetryl burster scatters the filler over the surrounding area.

VT NOSE FUZE MK 172 MOD 0.—The Mk 172 Mod 0 is a proximity fuze armed, like other nose fuzes, by a combination of air travel and inertia. Its operation is similar to that of VT bomb fuzes and it will cause an air burst of the rocket head at distances between 10 and 40 feet from the target. It is particularly effective against personnel without top cover, such as men in foxholes and slit trenches and exposed gun crews aboard ship. This fuze is used in air-to-ground firing only and requires a special deep cavity rocket head to accommodate it. It may be used in either the 5-inch (3.25-inch motor) aircraft rocket or the 5-inch high-velocity aircraft rocket. The Mk 172 Mod 0 fuze may be easily recognized by its exposed 10-bladed arming vane which is surrounded by an antenna ring.

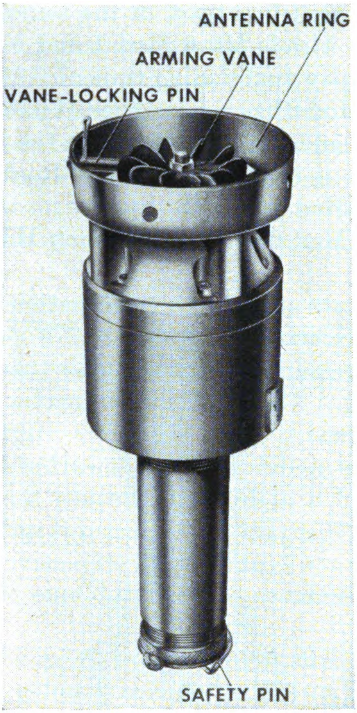


Figure 6–8.—VT Nose Fuze Mk 172 Mod 0.

Caution: There is no external evidence of arming. If the vane lock pin is missing from the antenna ring, the fuze must be disposed of.

Base Fuzes Mk 163 and Mods, Mk 164 Mod 0, Mk 165 Mod 0, and Mk 166 Mod 0

These fuzes function alike, differing only in delay and the rocket heads used.

Fuzes Mk 163 Mods 0 and 1 are used in 11.75-inch Rocket Heads (Common) Mk 2 Mod 0 or 1, three fuzes being installed in each head to insure detonation. A delay functioning time of 0.02 second is obtained by means of a delay element in the explosive train.

Fuze Mk 164 Mod 0 is used in the 5-inch HVAR High Explosive (HE) Heads Mk 6 Mod 1 and Mk 6 Mod 4 and incorporates a delay functioning time of 0.015 second.

Fuze Mk 165 Mod 0 has a delay time of 0.02 second and has an adapter ring added for assembly to the 3.25-inch motor Mk 7. The fuze is used in 5-inch HE Rocket Heads Mk 1 Mod 0 and Mk 1 Mod 1.

Fuze Mk 166 Mod 0 is used in 5-inch HVAR HE Head Mk 2 Mod 2.

All four fuzes are armed by a combination of gas pressure, inertia, and deceleration. Between 275 pounds and 325 pounds of gas pressure within the motor tube is required for complete arming. They fire due to inertia of the internal parts upon impact.

These fuzes are modifications of an earlier fuze, the Mk 157 shown in figure 6–9, and have essentially the same functioning mechanism. Certain safety features such as a gas check to keep pressure and heat from the explosive filler have been added and performance on heavy oblique impacts has been improved.

The operation is as follows (refer to fig. 6–9): Gases from the rocket motor enter the pressure chamber through a small opening in the inlet screw, debris from the burning propellant being filtered out by the inlet screen. When the pressure in the chamber is between 275 pounds and 325 pounds per square inch (when burning is about half completed) the diaphragm collapses. The arming plunger is forced inward, shearing the shear wire which holds the plunger in place. Movement of the arming plunger releases the locking ball which, in the unarmed position, holds the firing pin body in place. This permits the firing pin body to move to the rear under the force of its own inertia and action of the firing pin spring. The firing pin is thus withdrawn from the shutter which, in the unarmed condition, is locked in the safe position.

When the rocket accelerates, the inertia of the shutter forces it back against the firing pin guide, compressing the shutter spring and engaging a shutter-locking pin in a hole in the firing pin guide. About midway during acceleration, the firing pin is withdrawn from the shutter, but the shutter, held by its locking pin, remains in the safe position.

When acceleration is over, the shutter spring forces the shutter forward against the lead-in disk, disengaging the shutter locking pin from the hole in the firing pin guide. The shutter spring then swings the shutter into the armed position, with the detonator assembly in line with the firing pin and lead-in, where it is locked by a detent.

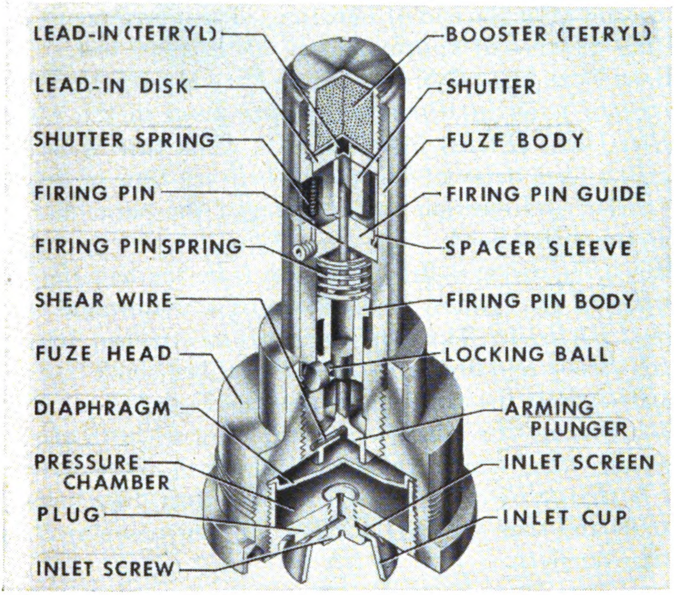


Figure 6–9.—Cutaway view of Base Fuze Mk 157.

Upon impact, the inertia of the firing pin body drives the firing pin forward, striking and initiating the percussion primer in the detonator assembly. This primer initiates the explosive train in the detonator assembly which in turn detonates the lead-in, booster, and main charge.

Fuzes Mks 163, 164, 165, and 166 are detonator-safe. In the unarmed position the detonator assembly is out of alinement with the explosive train. Should the detonator function prematurely, the force of the explosion will be dissipated upward through a hole in the firing pin guide, away from the balance of the explosive train. Because of the delay in admission of gas from the motor to the pressure chamber, the first stage in arming does not occur until about one-half the burning time of the motor has been completed.

Because of this delay, if the rocket motor blows up before it leaves the launcher, the fuze should not arm. The burning distance of the rocket varies with the temperature as already noted and, on the average, fuze arming is completed about 0.1 second after the end of burning. This corresponds to an arming distance of approximately 600 to 1,000 feet.

BASE FUZE MK 127 MOD 0.—Base Fuze Mk 127 Mod 0 (obsolescent) is an ignition-ejection fuze used in the 3.5-inch Rocket Head (Flare) Mk 15 Mod 0. The fuze is designed to give a fixed delay of 7.5 seconds between time of firing of the rocket and ejection and ignition of the parachute flare from the rocket head.

When the rocket is fired, pressure from the burning black powder in the igniter forces forward a diaphragm in the base of the head. The diaphragm has an attached firing pin which strikes and fires a modified .32 caliber blank cartridge. The flash from the cartridge ignites the Fuze Mk 127 Mod 0. which consists of a plastic case containing a length of safety fuse, one end of which is exposed to the flash of the cartridge, and a charge of black powder. The safety fuse burns 7.5 seconds and then ignites the black powder which ejects and ignites the flare.

COMPLETE ROUNDS OF ROCKET AMMUNITION

2.25-INCH SUBCALIBER TRAINING ROCKETS.—The two types of subcaliber training rockets provided for training and practice are referred to as SCAR's (Subcaliber Aircraft Rocket) and both use the same head, the Mk 3 Mod 2. This head is made of zinc, weighs 1.6 pounds, and is solid.

Two motors are used and the propellant grain in each is cylindrical. The motor tubes have two button type suspension lugs which require an adapter to load onto a service type launcher. Lugs and tail fins are welded to the motor tube.

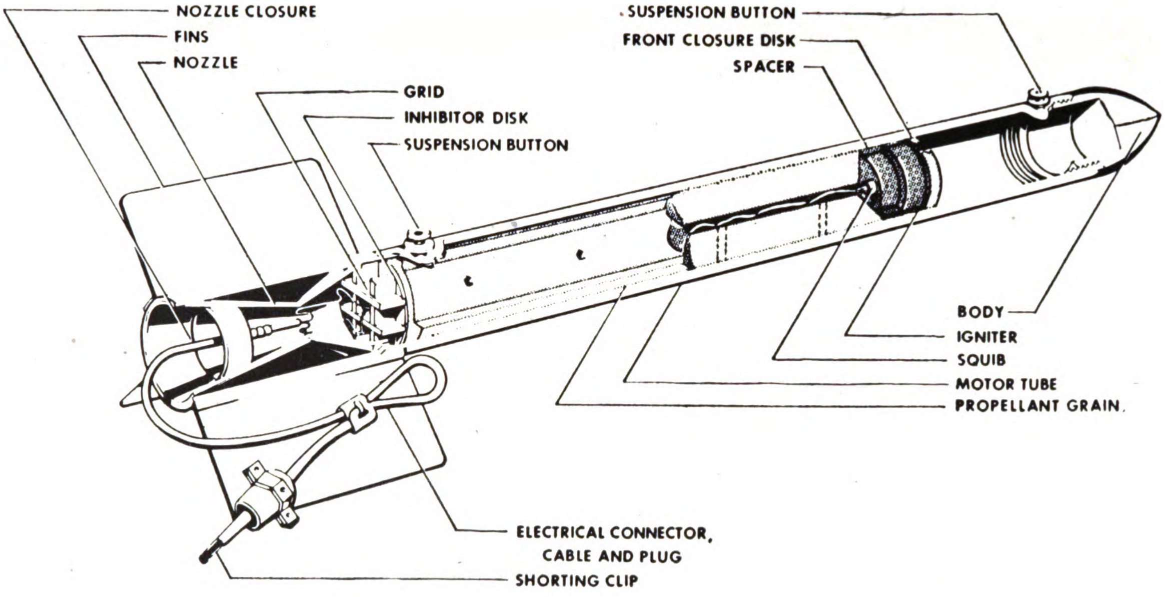


Figure 6–10.—The 2.25-inch subcaliber aircraft rocket.

The two complete rounds listed below are 29 inches in length and weigh approximately 11.5 pounds.

The 2.25-inch SCAR Mk 1 Mod 0 uses Motor Mk 11 and Mods, has a velocity of 1,130 feet per second (f. p. s.), and is used as practice ammunition for the 3.5-inch aircraft rocket or the 5-inch HVAR.

The 2.25-inch SCAR Mk 2 Mod 1 uses Motor Mk 13 and Mods with a velocity of 775 f. p. s. and is used as a practice rocket for the 5-inch aircraft rocket with 3.25-inch motor. (See fig. 6–10.)

AIRCRAFT ROCKETS UTILIZING THE 3.5-INCH MOTOR MK 7 AND MODS.—The 3.25-inch Motor Mk 7 and Mods is assembled with various 3.5-inch and 5-inch diameter heads to make five different types of service rounds: solid, smoke, flare, general-purpose, and practice. The 3.5-inch head is used for the solid, smoke, and flare rockets.

Solid—The 3.5-inch Rocket Head (Solid) Mk 8 Mod 0 or 1 is a 20-pound solid steel head designed for maximum underwater travel and penetration and has a double ogive shape (see fig. 6–11). When fired at angles of 20° and less, the rocket has a lethal underwater range of 120 feet—that is, it will penetrate the hull of a submarine after an underwater travel of 120 feet or less. The rocket is primarily an antisubmarine weapon but it may be used against any lightly armored vessel or vehicle. The complete round, when assembled, is designated the 3.5-inch ROCKET MK 1 MOD 0 (AIRCRAFT SOLID). The assembled rocket is 56.5 inches long, weighs 55 pounds, and has a maximum velocity of 1,140 f. p. s.

Smoke—3.5 inch Rocket Head Mk 6 Mod 0 is a smoke head filled with either FS smoke mixture (sulfurtrioxide-chlorsulfonic acid) or PWP (plasticized white phosphorus). Nose Fuze Mk 155 Mod 0 is used to scatter the filler on impact and no base fuze is installed. The rocket is used to lay aerial smoke screens ahead of landing craft, and to mark targets and range salvos of high-explosive rockets. When the filler is FS smoke mixture, the complete round is designated 3.5-inch ROCKET MK 3 MOD 0 (AIRCRAFT SMOKE) and when the filler is PWP the designation is 3.5-inch Rocket Mk 3 Mod 1 (Aircraft Smoke). Both rounds are 69.5 inches long, weigh approximately 55 pounds, and have a maximum velocity of 1,140 f. p. s.

Flare—The 3.5-inch Rocket Flare Head Mk 15 Mod 0 contains the Rocket-Head Load (Flare) Mk 7 Mod 1 and Base Fuze Mk 127 Mod 0, and is used to illuminate or silhouette surface or ground targets. The flare is ejected and ignited 7.5 seconds after the firing of the rocket and burns for 28 seconds at an average candlepower of 800,000, descending at the rate of 40 feet per second. The complete round is designated 3.5-inch Rocket Mk 6 Mod 0 (Aircraft Flare) and is 67 inches long, weighs approximately 51 pounds, and has a velocity of 1,200 f. p. s.

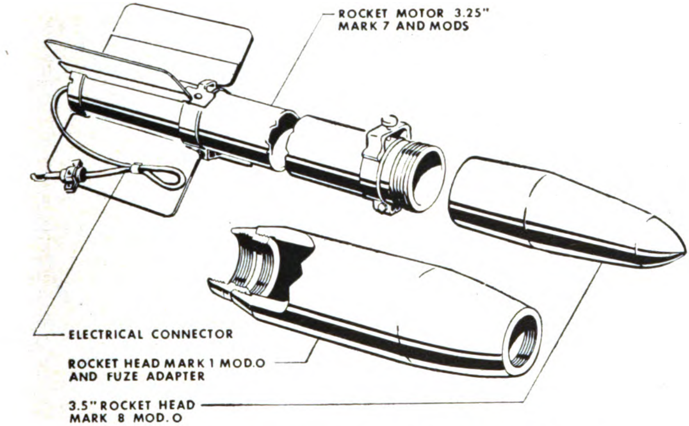


Figure 6–11.—Components of the 3.5-inch aircraft rocket.

General-Purpose—The two GP rockets which use the 3.25-inch Motor Mk 7 and Mods use 5-inch diameter heads and thus are classified as 5-inch rockets. The heads are converted 5-inch .38 caliber gun projectiles and both nose and base fuzes are installed. The filler of the 5-inch Rocket Head Mk 1 is 8.6 pounds of TNT while the Rocket Head Mk 1 Mod 1 contains 8.4 pounds of TNT. The reduction is necessary due to enlargement of the nose fuze cavity to accommodate the VT fuze.

1. The 5-inch HE Rocket Head Mk 1 Mod 0 uses Nose Fuze Mk 149 Mod 0 and Base Fuze Mk 165 Mod 0 (fig. 6–4). The complete round is designated 5-inch ROCKET MK 1 MOD 2 (AIRCRAFT GENERAL-PURPOSE) and is 66 inches long, weighs 83 pounds, and has a maximum velocity of 715 f. p. s.

2. The 5-inch HE Rocket Head Mk 1 Mod 1 is the same as the Mk 1 Mod 0 except for the nose fuze cavity, which is enlarged to accommodate the VT Nose Fuze Mk 172 Mod 0. Base Fuze Mk 165 Mod 0 is installed. The complete round is designated 5-inch ROCKET MK 1 MOD 5 (AIRCRAFT GENERAL-PURPOSE) and is 69 inches long, weighs 81 pounds and has a maximum velocity of 715 f. p. s.

Practice—The 5-inch HE Rocket Head Mk 1 Mod 0 is filled with plaster to make a practice head. No fuzes are installed but the flat nose shipping plug must be replaced with a conical nose plug (fig. 6–4). The complete round is designated 5-INCH ROCKET MK 2 MOD 0 (AIRCRAFT PRACTICE), is 66 inches long, weighs 83 pounds, and has a maximum velocity of 715 f. p. s.

AIRCRAFT ROCKETS UTILIZING THE 5-INCH HIGH VELOCITY AIRCRAFT ROCKET MOTORS.—Several combinations of general-purpose, antitank, and practice rockets use the High Velocity Aircraft Rocket (HVAR) Motors Mk 2 Mod 3 or 4 and Mk 10 and Mods. All the heads used, with one exception, are of 5-inch diameter, and all the 5-inch high-velocity rockets have a maximum velocity of 1,360 f. p. s. Ballistite is the propellant used.

The 5-inch HVAR motor consists of a seamless steel tube with internal threads on both ends. At the rear is a nozzle plate having eight nozzles arranged in a circle and a larger central blowout nozzle closed by a copper disk. The blowout nozzle acts as a safety valve, the copper disk being designed to blow out if the internal pressure exceeds 2,400 pounds per square inch which is the normal maximum pressure when the propellant grain temperature is 100° F. In this manner, the usable temperature range of the rocket is increased.

Motors as currently issued have the lug bands positioned 24 inches apart for installation on Areo 14A launchers. If the rocket is to be used with the Mk 9 launcher, the two button lug bands are positioned as indicated by the two positioning holes located six inches apart on the motor tube. Motors Mk 2 Mods 3 and 4 and Mk 10 Mod 4 do not have the extra tunnel lug band for installation on the Aero 14A Launcher.

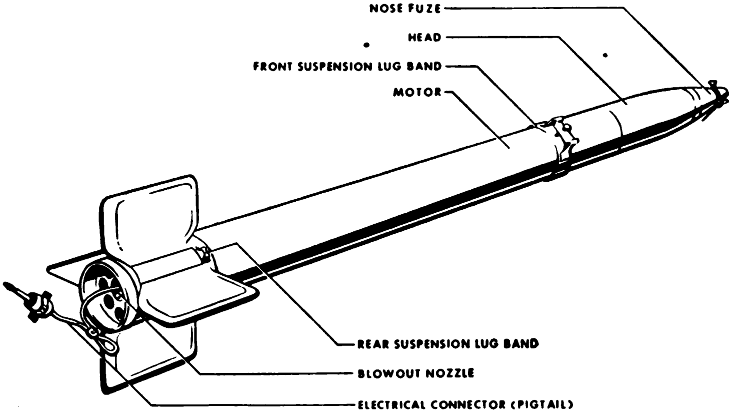


Figure 6–12.—5-inch High-Velocity Rocket (Aircraft General-Purpose).

The various heads used in 5-inch HVAR's are listed below:

The 5-inch HE Aircraft Rocket Head Mk 6 Mod 1 is used with either HVAR Motor Mk 2 and Mods or HVAR Motor Mk 10 and Mods. This head is fuzed with Nose Fuze Mk 149 Mod 0 and Base Fuze Mk 164 Mod 0, and contains approximately 7.5 pounds of TNT. The same head, filled with plaster and with a conical nose plug, is assembled to the Mk 2 and Mods motor to make a practice rocket. The complete GP or practice rocket is 69 inches long and weighs about 137 pounds.

The 5-inch HE Aircraft Rocket Head Mk 6 Mod 4 is similar to the Mk 6 Mod 1 head except for an enlarged nose fuze cavity for installation of the VT Nose Fuze Mk 172 Mod 0. Base Fuze Mk 164 Mod 0 is used. This head is assembled to HVAR Motor Mk 2 and Mods to make up the complete round.

The 5-inch HE Aircraft Rocket Head Mk 2 Mod 2 is used with HVAR Motor Mk 2 and Mods or HVAR Motor Mk 10 and Mods. The head uses Base Fuze Mk 166 Mod 0 and a nose fuze is not installed.

ANTITANK AIRCRAFT ROCKET (ATAR) HEADS cannot be discussed in detail in this text. The 6.5-inch ATAR head is being superseded by a 5-inch head; fuzing of the two differs but the principle is the same. Both heads are so-called "shaped charges" which employed the "Munroe effect" to

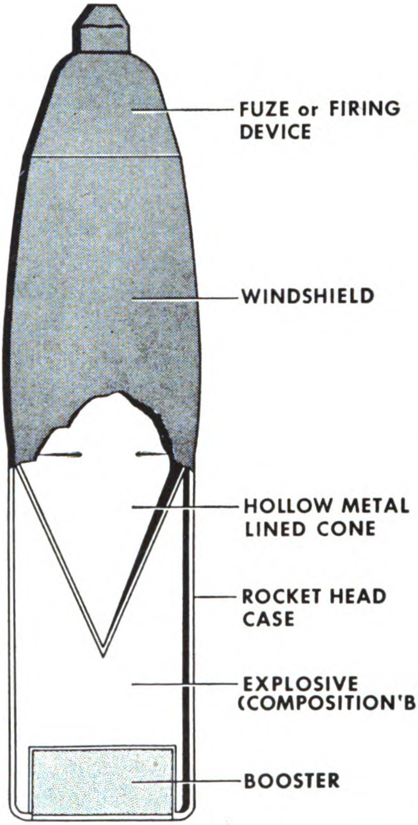


Figure 6–13.—Typical shaped-charge rocket head.

penetrate the surface of the target with a jet of gas and molten metal particles in much the same manner that a stream of water from a hose will penetrate mud. A typical shaped charge is shown in figure 6–13. While detonation of a shaped-charge head always occurs outside the target, the stream of gas and metal particles will penetrate a very considerable amount of armor plate at a speed of about 30,000 f. p. s. Once inside the target, this stream fans out and anything in its path will be damaged, destroyed, or rendered a casualty, as the case may be.

The windshield is a thin metal cone which has a two-fold purpose: (1) it streamlines the nose and (2) it holds the fuze or firing device the correct distance ahead of the main body. In order to take maximum advantage of the Munroe effect, a shaped charge must be detonated when the main charge is a definite distance from the target surface. Penetration and effect is also controlled by the depth and size of the metal-lined cone which is indented into the front of the explosive charge. This indented cone produces the Munroe effect with its stream of gas and molten metal.

The explosive filler in both types of heads is Composition B, and while the heads are primarily designed for use against heavily armored tanks, they have a blast and fragmentation effect slightly better than that of standard GP heads.

11.75-INCH ROCKET (AIRCRAFT COMMON).—This rocket, largest service rocket to date, consists of the Mk 2 Mod 0 motor and the Mk 4 Mod 2 head and is 115 inches in overall length, weighs 1,178 pounds, and has a velocity of 900 f. p. s. It is called the "Tiny Tim" and has proved effective against shipping, heavy fortifications, coastal defenses, and oil storage facilities.

Motor Mk 2 Mod 0 is approximately 72 inches long; this is about 10 inches shorter than earlier motors to facilitate handling aboard ship. The nozzle plate which is screwed into the after end of the motor tube contains 24 nozzles arranged around a larger central blowout nozzle which is closed by a copper shear disk. In normal operation the gases from the burning propellant do not pass through the central nozzle, but if the internal pressure exceeds approximately 2,000 pounds per square inch, the shear disk is expelled, bringing the central nozzle into operation. This feature allows the motor to operate satisfactorily over a wider temperature range.

Inside the motor tube are 4 grains of propellant with a metal-cased igniter composed of ½ pound of black powder and 2 electric squibs wired in parallel and connected to receptacles in the nozzle plate. The 4 propellant grains, which have a total weight of 150 pounds, are shielded from each other and supported in the tube by a charge support which extends almost the whole length of the tube (fig. 6–14). The grains and charge support are supported by the grid which is bolted to the nozzle plate to make the whole assembly rigid.

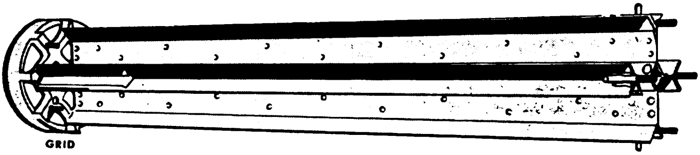


Figure 6–14.—Grid and charge support assembly (4-Y construction).

Two suspension bands with standard bomb lugs are located 14 inches apart on the motor tube for attaching the round to a bomb rack or shackle, and a hoisting band is located near the center of gravity. The rocket is not only too large to fit on any standard launcher, but emits such a volume of gas and flame when ignited that any adjacent wing surface would be burned. Instead, the rocket is dropped from the rack or shackle and after clearing the launching plane is ignited by an attached magneto firer.

The magneto firing device is designated Rocket Firer Mk 3 Mod 0 or 1 and is secured in a housing attached to the tail end of the rocket between the fins. Coiled inside the housing is a lanyard, secured at one end to the magneto armature and at the other to the aircraft. When the rocket drops free of the launching aircraft, the lanyard pays out until it is extended 16 feet, when it actuates the magneto armature. The current thus generated is fed through the electrical connectors to the two squibs in the igniter and ignites the black powder charge and propellant grains.

Mod 1 is essentially the same as Mod 0 but has a small hole in its rear plate through which a copper wire extends to indicate the armature is in the safe or nonfiring position. If the wire is not visible, the rocket must not be loaded until the firer has been properly adjusted.

The fins are shown in figure 6–6 and are aluminum, 10 inches by 24 inches. They are attached to the motor by two bands which are clamped around the tube at the time of assembly.

The 11.75-inch **Rocket Head Mk 4 Mod 2** is the regular service-issue head. It weighs approximately 578 pounds as fired, contains 148.5 pounds of TNT and is fuzed with three Base Fuzes Mk 163 Mod 0 or 1. A nose fuze is not used. The head is equipped with a handling band which must be removed after assembly.

Early type Tiny Tim heads were modified 500-pound SAP bombs AN–M58A1.

AIR-TO-AIR ROCKET DEVELOPMENTS

One of the latest developments in rockets is the air-to-air rocket known as the "Mighty Mouse," officially designated the **2.75-inch Folding-Fin Aircraft Rocket (FFAR) Mk 1 and Mods.** In its present stage of development, this rocket is powerful enough to destroy an enemy aircraft with a single hit and was designed primarily for use by fighter planes against attacking bombers.

The Mighty Mouse is carried in and launched from a tubular launcher. Fixed fins would be impractical in such a launcher, so the fins are the folding type; when stowed in the launcher, the fins are folded behind the motor tube and lie within the diameter of the round. When launched, the fins flip out into the windstream as the rocket emerges from the launcher tube.

The 2.75-inch FFAR's are carried and launched from "pods" which are hung from aircraft wings and fuselages on bomb racks and shackles. These pods permit rapid rearming of fighter and attack aircraft aboard carriers, where time is often vital. Two pods have been developed, one holding seven Mighty Mouse rockets and a larger one with 19 rounds. Each rocket has its own launching tube. The pods are made of cardboard impregnated with plastic and the rockets (less heads) are stored in the pods for shipment and storage in magazines. When used, the heads are installed, streamlined frangible nose and tail caps are placed on the main container, and the assembly is loaded on the aircraft. The cardboard pod is jettisoned after firing; it is both cheap and light and especially valuable for fast arming or rearming of planes.

It is obvious that a tremendous amount of firepower is thus available on the individual aircraft. If a plane has 12 rocket launchers and a 19-rocket pod is loaded on each, the plane could fire a total of 228 rounds of 2.75-inch missiles. These rockets are almost as effective as a 75-mm gun projectile.

PAINTING AND MARKING

Service ammunition is painted with lusterless paint to prevent rust and in various colors to provide means of identification. Ammunition items are marked by stamping in the metal, or by stenciling, the type, size, model, and lot number. The safe temperature range for storage and use is shown on the rocket motor.

In general, rocket motors are painted olive drab. The colors used for painting Navy rocket heads are as follows:

High-explosive	Olive drab; marking in white.
Chemical (casualty gas)	Gray; green band, lettering in white.
Chemical (smoke)	Gray; yellow band, lettering in white.
Practice	Blue; marking in white.
Inert	Black; marking in white.

ASSEMBLY AND LOADING

Assembly of the component parts of an aircraft rocket into a complete round ready for firing is one of the duties of the Aviation Ordnanceman. Rockets should not be assembled until shortly before use. A motor is mainly a fire hazard until the head is assembled to it, after which it will travel at full velocity if accidentally ignited.

These instructions are general in scope and the Aviation Ordnanceman should refer to the Ordnance Pamphlet dealing with the specific rocket to be assembled unless thoroughly experienced. Fully detailed assembly and loading instructions may be found in the various Ordnance Pamphlets and Aircraft Erection and Maintenance Manuals.

After the component parts are removed from their shipping and storage containers, they should be carefully inspected for damage such as bent fins, burred or damaged threads on motors and heads, and dented motor tubes. Depending on the size and type of rocket, various assembly jigs or kits are usually needed. Remove the tail shipping cap which protects the electrical connector in the rear of the motor.

Caution: Leave the shorting clip or shorting plugs installed. Be careful not to break nozzle closure disk or damage the electrical connector during subsequent operations.

Push the fin assembly onto the rear end of the motor until it is properly positioned and secure it in place. See that the lug bands are the proper type for the launcher to be used, and are properly positioned and tightened.

Unscrew the front shipping cap from the motor tube. Do NOT remove the cardboard spacers or felt washers unless specific OP instructions so state. Remove the thread or base fuze protector from the rocket head if installed. In assembling larger rockets the mating threads on head and motor should be oiled or coated with grease, as large threads are likely to gall if not lubricated. ***Warning:*** If a high-explosive head is being used, make certain the base fuze is securely installed. The head will explode when the motor is fired if the round has been assembled without the base fuze.

Screw the head onto the motor, using a suitable wrench. In assembling most rockets, a strap wrench is employed. Unless care is taken with the smaller motors, cross-threading may occur between head and motor; this usually results in separation of the head and motor when fired.

If the head used has a nose fuze cavity, remove the nose shipping plug, inspect the fuze cavity and threads, make certain the auxiliary booster is installed, if required, and install the fuze. Do NOT remove the fuze safety wire or ready the fuze until the rocket is loaded on the launcher.

Place the assembled rocket horizontally on the deck or on racks. Do not stand the rocket on its tail as this may damage the electrical connector.

With the exception of the 11.75-inch Tiny Tim rocket, the launcher firing circuit must be checked for continuity prior to loading; and before plugging in the rocket pigtails, a "no-voltage" test must be made to be sure there is no stray voltage in the circuit which would fire the rocket as soon as plugged in. As already noted, the Tiny Tim is loaded on a bomb rack and fired by an attached magneto firer. In addition, if the rocket motor is suspected of being defective, a continuity test should be made on the igniter circuit. Three test devices are available for these tests: CIRCUIT TEST PLUG MODEL I for checking circuit continuity, ROCKET LAUNCHER FIRING CIRCUIT TESTER, ASO No. R94–K–500225 for no-voltage tests, and CIRCUIT CONTINUITY TESTER 680A for checking the continuity of the igniter circuit within the rocket motor.

TEST PLUG MODEL I is a compact plastic plug with a 26-volt light bulb and an electrical plug with a Type A single pin Adapter to match the launcher receptacle or launcher Type B Adapter (fig. 6–15). CONTINUITY TESTS SHOULD NEVER BE MADE WITH ROCKETS LOADED ON THE LAUNCHERS.

To perform a continuity test proceed as follows:

1. Inspect and verify that there are no rockets loaded on launchers.
2. Insert one test plug into each rocket launcher receptacle.
3. Close all necessary switches.
4. Actuate the rocket firing switch.

5. Verify that the test plugs light in the proper sequence by checking the test lights with each setting of the station distributor or rocket selector switch.

Operation of the fuze arming controls should be checked at the same time the circuit continuity tests are made.

After circuit continuity has been established, loading of the rockets on the launchers may begin when directed by the rocket safety officer in charge. All switches must be off and all launchers should be inspected to insure that all fittings are secure, no obstructions foul the lug slots or latch mechanisms, and that all moving parts are in working order. Loading may be done in the same areas designated for the loading of bombs or aircraft guns. Electrical plugs, however, must not be inserted until after the no-voltage test has been made. Aboard carriers, the plugs shall not be inserted until the plane is on the flight deck. At Naval Air Stations planes shall be pointed in the safest direction when inserting plugs.

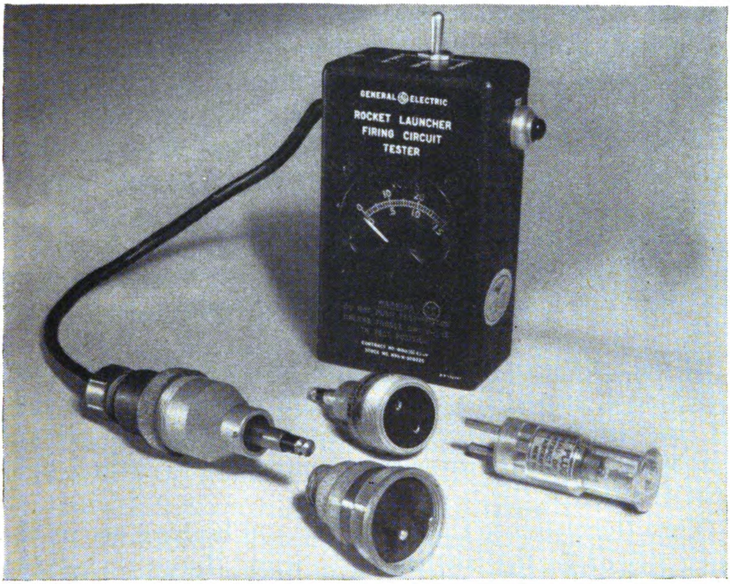


Figure 6–15.—Circuit Test Plug Model I with Type A Adapter and Rocket Launcher Firing Circuit Tester ASO No. R94–K–500225 with Type B Adapter.

The safest direction is that direction in which the least damage would be done to persons or property by the accidental firing of a rocket.

In loading, the rocket (except the 11.75-inch Tiny Tim) is lifted parallel to the launcher and the front lug button and rear lug loop fitted into the front slot and rear tongue of the launcher respectively. In the case of the 2.25-inch SCAR, which has two button lugs, the buttons are slid aft into the rail of the adapter which must be fitted to the service launcher. The Tiny Tim is hoisted onto its bomb rack or shackle in the same manner that a bomb is loaded. The latches of the service type launchers will close automatically as the rocket is loaded onto the launcher, holding the rocket firmly until the latch is released electrically when the rocket is fired. SCAR adapters require the installation of a shear wire to keep the latch closed until fired. Use only the prescribed shear wire.

Insure that the round is firmly held by trying to push it forward and aft. Do NOT PLUG IN THE ELECTRICAL CONNECTOR. Let it hang loose, and do not remove the shorting clip.

If the head is the high-explosive type with Nose Fuze Mk 149 Mod 0, inspect the cap and clamp assembly on the fuze. If they are badly corroded, do not use them. To prevent corrosion and icing, cover the clamp assembly with a light coat of vaseline.

Turn the clamp so the clamp pin and bushing are on the same side of the fuze as the arming wire. Insert the arming wire into the hole which is provided next to the safety wire and then remove the safety wire. Do NOT reverse this order. Insert the arming plate on the end of the arming wire into the fuze arming control.

Put ONE Fahnestock clip on the end of the arming wire and slip it down against the clamp bushing after removing slack from the wire. Cut off the excess wire, leave 3 or 4 inches extending beyond the fuze, and dress off all burrs.

If the VT Nose Fuze Mk 172 is installed, install the arming wire in the vane locking pin after the seal wire is removed.

The locking pin may be positioned in one of four holes. Do NOT use a Fahnestock clip on this fuze.

Rocket pigtails should be plugged in just prior to takeoff. Before plugging in, the no-voltage check must be made, using either the Rocket Launcher Firing Circuit Tester (ASO Stock No. R94–K–500225) or a voltmeter with a 0–30 and 0–1.5 volt scale modified to include a 5 watt, ½-ohm resistor across the 1.5 volt circuit of the meter. The standard circuit tester (R94–K–500225) incorporates this resistor as part of the unit. It has the two scales on its face, a 3-position switch on the top marked "Test", "0–30", and "0–1.5", and a "Test" button on the side (fig. 6–15). The switch must be on the "Test" position before pushing the "Test" button. When testing the meter for proper operation, at least 28 volts must be indicated on the scale.

The circuits shall be readied for testing by closing all necessary switches EXCEPT the firing switch and setting the station selector or station distributor to each station to be tested in turn. Test the circuit tester for proper operation; then plug the 0–30 volt circuit into the station corresponding to the setting of the station selector or station distributor and:

1. Energize and de-energize all other control circuits which pass through connector receptacles common to rocket circuits and observe needle of the instrument.

    a. If a steady state or surge voltage exceeding 1.5 volts is observed, follow procedure in Item 2 below.

    b. If a steady state or surge voltage, 1.5 volts or less, is observed, repeat test using 0–1.5 volt circuit of instrument.

    c. If a steady state or surge voltage is still observed with the 0–1.5 volt circuit of test instrument, follow procedure in Item 2 below.

    d. If no voltage is indicated with the 0–1.5 volt circuit, follow procedure in Item 3 below.

2. **RESTRICT AIRCRAFT FROM CARRYING ROCKETS UNTIL SUCH TIME AS THE CAUSE OF THE STRAY VOLTAGE IS DETERMINED AND ELIMINATED.**

3. Check the 0–1.5 volt circuit of the test instrument by applying a known potential.

a. If the needle of the instrument now moves, the circuit is safe. Proceed testing next station. After all stations have been checked and found safe, follow instructions of next paragraph.

b. If the needle does not move after applying known potential, a defective instrument is indicated. Repeat test with a different instrument.

After testing each and every station and no stray or surge voltage is indicated, turn off all switches. The circuits are safe and plugging in may commence. The preferable procedure is to plug in the rounds on each wing consecutively from inboard out. Shorting clips should be saved for future use in case any round is not fired. When plugging in, the Aviation Ordnanceman should stand to one side of the round being connected and to one side of rounds already connected to avoid the rocket blast in case of accidental ignition.

If a rocket motor is suspected of being defective, the CIRCUIT CONTINUITY TESTER 680A provides a definite check of the igniter circuit. The 680A is an electric instrument based on the Wheatstone bridge circuit and consists of a meter, a switch, 2 external sockets, a battery, and 2 tests leads. It is used to test the resistance of the rocket's igniter; if the resistance is either too high or too low, the motor must not be used.

The meter has a double scale (fig. 6–16). The lower scale, marked "HVAR" is to be used only with the 5-inch HVAR rocket and the 11.75-inch aircraft rocket. The upper scale indicates the resistance of the circuit of all other motors. An adjusting screw is provided to zero the pointer before use.

A two-pin socket and a single pin jack-plug type socket are located on the side of the instrument for insertion of rocket igniter plugs.

The 2 test leads are for testing rockets that do not have electric plugs leading from their igniters. Most ground and surface rockets, as well as some newer aircraft rockets, fall into this category. The test leads are connected by a single pin plug at one end, each of the other ends having a prod.

To check the battery prior to use, the plug for the test leads must be removed from the socket and the switch turned to "BATT CHECK." Note the reading on the dial. A good battery is indicated by a pointer deflection to the right of the line marked "BATTERY OK." A low battery is indicated by a pointer deflection to the left of the "BATTERY OK" line. A weak battery must be replaced.

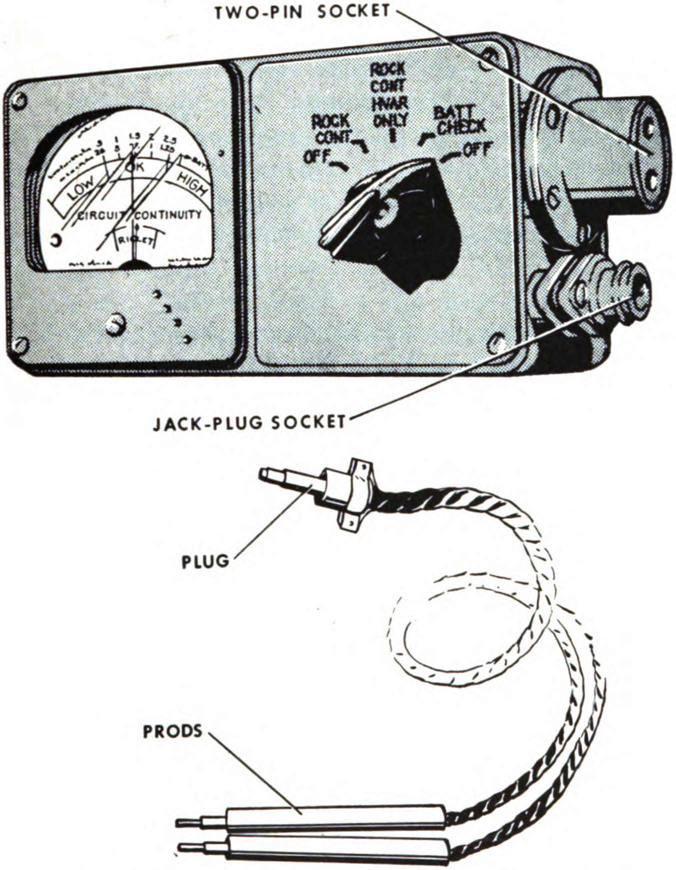


Figure 6–16.—Circuit continuity tester 680A with test leads.

The procedure for testing the internal electric circuits of rockets is as follows: ***Caution:*** NEVER test equipment that contains batteries or other sources of electricity as it may damage the meter.

1. Rockets with electric plugs.

a. Check the battery.

b. Turn the switch to the type of rocket being tested. For 5-inch HVAR rockets and 11.75-inch rockets, turn the switch to "ROCK CONT HVAR ONLY." For other rockets, turn the switch to "ROCK CONT."

c. Remove the shorting clip from the pigtail plug. Plug the rocket into the appropriate socket on the instrument. Note the movement of the pointer.

d. If the pointer rests within the space marked "OK" the rocket is satisfactory for use. Do not use if the pointer rests within the "LOW" or "HIGH" sections of the scale.

e. Remove the rocket plug from the socket and turn the switch to the "OFF" position. Replace the shorting clip on the plug.

2. Rockets with contact rings, shrouds, or contact disks.

a. Test the battery.

b. Connect the test leads plug into the single prong socket.

c. Turn the switch to "ROCK CONT."

d. Remove the shorting clip or strip from rocket. Touch one prod to one shroud, contact ring, or contact disk. At the same time touch the other prod to the other shroud, contact ring, contact disk, or body of the rocket and note the movement of the pointer.

e. If the pointer rests within the space marked "OK" the rocket is satisfactory for use. Do not use if the pointer rests within the "LOW" or "HIGH" sections of the scale.

f. Remove the prods from the rocket and remove the leads from the instrument. Turn the switch to "OFF." Replace the shorting strip or clip on the rocket.

Warning: Igniter circuits shall be checked only when the rocket is nonpropulsive, that is, before assembly of heads and motors. All personnel shall keep clear of the ends of the motor in case of accidental ignition.

All tests of rockets and launchers should be made in conformance with current orders of the Bureau of Aeronautics and commands concerned with rocket firing. It should be noted that loading and testing procedures may differ from one unit to another and all local orders should be complied with in these operations.

GENERAL SAFETY PRECAUTIONS

Fuzes

Rocket fuzes shipped in sealed containers, such as Mk 149 nose fuzes, are to remain in the sealed cans during stowage. As a rule, nose fuzes are stowed in a ship's bomb fuze magazine, or under conditions specified by the Bureau of Ordnance. Cans should be placed upright in assigned magazines and secured firmly.

Fuzes are relatively sensitive and must be handled with care to avoid extreme shocks which might cause damage. Operations such as fuzing, unfuzing, assembly, or disassembly of all types of munitions should be carried on at a distance from other explosives and from vital installations. Only the minimum number of persons and rounds required should be in the vicinity. The ideal situation would be to permit work on only one round at a time, on a deck or at some other location remote from all magazines, ready stowage, explosive supplies, or vital installations.

Examination of the exterior of some fuzes, such as the Mk 164 Mod 0, does not indicate whether they are armed. If for any reason it is thought a fuze might be armed, it should be treated as an armed and sensitive fuze. No attempt should be made to remove it from the rocket head. The complete fuzed round should be disposed of by gently lowering it tail-first into deep water. If available, explosive-ordnance-disposal personnel will dispose of such rounds in accordance with their instructions.

Disassembly of rocket fuzes is not permitted except as authorized by the Bureau of Ordnance.

NEVER ATTEMPT TO REMOVE A BASE FUZE FROM THE ROCKET HEAD.

The aircraft rocket is no more dangerous than any other explosive weapon, but it does have certain peculiar hazards. A completely assembled rocket, if accidentally fired, will take off under its own power in the direction in which it is pointed, with threat of damage to anything in its path. When fired, an assembled rocket expels a blast of burning gas capable of injuring or killing anyone it strikes, because of concussion or burns.

Four hazards exist in dealing with aircraft rockets:

1. Inadvertent electrical contacts which may set off the rocket.
2. Excessive temperatures or pressures which may cause the motor to explode in a ground fire or in the air when fired.
3. Continued exposure to abnormal storage temperatures which may cause the propellant to deteriorate, with attendant hazards of possible explosion when the rocket is fired.
4. Rough handling or blows which may break the propellant grain, thus exposing too much surface to burning and leading to possible excessive pressures in the motor when fired.

Generally, a rocket motor without a head attached is unlikely to explode. It does present a potent fire hazard since ballistite or SPCG ignites easily and burns readily. High-explosive heads, either fuzed or unfuzed, present the same risk as do gun projectiles under the same conditions. Rockets, whether completely assembled or disassembled, must be handled with extreme care to avoid damage to parts.

Rocket motors should be stored in the same manner as smokeless powder. Matches and open flames must never be allowed in the storage area. Smoking should not be permitted in the loading area within 200 feet of any ammunition.

Rockets must be kept in a cool place out of the direct rays of the sun, to prevent an increase in temperature. A rocket must never be fired when its temperature is either greater or less than the safe firing range of temperature indicated on the motor tube. A rocket temperature may be considered to have returned to the safe firing range after the rocket has been exposed for six or more hours to a temperature within the safe firing range.

Rocket motors must not be stowed in the same compartments with or near radio apparatus or antenna leads, due to the possibility of induced currents igniting the motors.

High-explosive heads and fuzes (except base fuzes which are permanently installed in the head) must be stowed separately from each other, in the same manner as high-explosive projectiles.

Never attempt to remove the propellant grain from a rocket motor. Do not pull on the pigtail or otherwise subject it to strain.

Except when unavoidable due to battle conditions, motors must not be exposed to small-arms fire or high-velocity bomb or projectile fragments.

Loading Precautions

Prior to any loading operations, usually as the first step in readying planes for rocket firing, the continuity test of rocket-firing circuits of all aircraft should be made. Before each loading, the launchers or pylons shall be inspected to determine that they are free of damage or malfunctions. Testing the rocket-firing circuit with the launchers loaded, or while they are being loaded, is prohibited.

Just prior to loading, all armament switches must be checked to determine that they are in the OFF position.

If a shear wire is to be used, as in the case of SCAR adapters, only the shear wire specified for use with the particular rocket shall be used. In case of a relaunch with rockets from a previous flight, or an arrested landing, new shear wires must be used.

Planes should not be fueled while rockets are present or on the launchers.

Long trousers and long-sleeved shirts buttoned snugly about the wrists should be worn by personnel handling rockets, for partial protection against burns in case of accidental ignition. Loading crews should remain out of the fore and aft line of the rockets as much as possible.

Except in an emergency, all loading should be completed before the plane engines are started. Loading a plane with the engine turning up is difficult and dangerous.

Arming planes on the hangar deck is not recommended. Loading of the planes on the hangar deck is permitted at the discretion of the commanding officer when necessitated by operational requirements.

Just before the electrical connectors (pigtails) are plugged in, a no-voltage test must be made to determine that the rocket-firing circuit has not accumulated any induced electricity. Shorting clips on the pigtails must not be removed until the pigtails are being plugged in.

Rocket igniter circuits must be checked (using Circuit Continuity Tester 680A) only in a Bureau of Ordnance approved rocket assembly building which includes a suitable barricaded or isolated cell. A minimum number of personnel shall be present when rocket circuits are being tested. The 680A tester shall not be issued aboard ship without specific authority from the Bureau of Ordnance.

Parking of armed planes on the flight deck for extended periods of time is not permitted except for planes which are to be used the same day or which are for ready use. Pigtails are to be left disconnected with shorting clips in place.

Stowage of assembled rockets other than in the ready service compartment is prohibited. Do not stand the assembled rocket on its tail, since this may damage the pigtail.

When planes land after operation they shall be inspected for rocket misfires. If misfires are present the removal of such round or rounds shall be supervised by the rocket safety officer.

Unfired rockets, aboard ship, should be removed from the launchers, disassembled, and stowed in the proper magazines, except for rockets on planes which are to be used the same day or on ready planes. Armed planes on the flight deck create a hazard and a serious danger in the event of fire or strafing.

A JATO unit is a rocket motor designed to give an aircraft more power on takeoffs from rough seas, short fields, when heavily loaded, or any combination of these conditions. Two or more of these units are secured to the outer skin of an aircraft structure and fired electrically by the pilot at the proper instant to give maximum takeoff assistance. Each unit produces the equivalent of 300–400 horsepower.

Earlier types of JATO produced a great quantity of smoke when ignited. In addition, they had to be stored and fired within a definite range of temperatures, as is the case with rocket motors. The latter condition hampered the widespread use of JATO, as did the amount of smoke produced which often blanketed runways after use. Aircraft waiting for takeoff could not see the runway until the smoke dissipated. On calm days, this entailed a longer wait than desirable.

The newest type JATO is entirely smokeless, produces slightly more thrust, and is lighter in weight than earlier types. In addition, it can be fired at any temperature found anywhere in the world.

One of the most significant applications of JATO is to help seaplanes get off rough water faster. This permits rescues to be made in heavy seas which formerly would have prevented takeoffs.

IGNITER CAVITY.—The igniter cavity provides for the installation of a device to ignite the propellant charge. It is located on the nozzle end of the case.

IGNITER.—The igniter consists of a nichrome wire imbedded in a small charge of black powder. The lower end of the igniter is plastic and contains the main charge of black powder. When the JATO unit is fired, the nichrome wire becomes hot and ignites the black powder. The black powder primer in turn ignites the main charge. The burning of the black powder bursts the plastic container and allows the burning igniter mixture to spread over the face of the main propellant. This ignites the main charge at about

725° F. This cycle takes place normally in 1 to 2 seconds after closing the firing switch.

Eight igniters are shipped in a metal box, separately from the JATO units.

SAFETY DISK.—Located on the nozzle end of the unit, near the igniter cavity, the safety disk is designed to rupture if the internal pressure exceeds 3,200 pounds per square inch (normal pressure during operation is 1,800 p. s. i.). In this event, thrust is completely lost as all pressure is relieved, and the unit may or may not stop burning. If burning continues, it is harmless, but the unit may continue to burn from 10 to 15 minutes.

The older JATO unit is designated as JATO Mk 2 Mod 3 (14 AS 1000). The significance of the suffix is as follows:

1. 14—the unit's burning time in seconds.
2. A—Asphalt with perchlorate.
3. S—indicates solid filler.
4. 1000—pounds of thrust per second of burning.

The newer unit is designated 15 KS 1000, using the same system of symbols.

JATO comes under the cognizance of the Bureau of Aeronautics and full instructions in its handling and use may be found in various BuAer and NavOrd publications.

The nomenclature of a JATO unit is as follows (refer to fig. 6–17):

CASE.—The case is steel, cylindrical in shape, and closed at one end.

NOZZLE.—The nozzle is similar in shape and identical in purpose to the nozzle of a rocket motor, being a venturi tube designed to give maximum thrust against the closed end.

STAND ASSEMBLY.—Since 14 AS 1000 JATO units must always be stored nozzle end up, a stand assembly is welded to the closed end of the case. The stand is also used for hand grips during handling.

PROPELLANT CHARGE.—The propellant used in JATO Mk 2 Mod 3 (14 AS 1000) is a solid composed of 75 percent potassium perchlorate and 25 percent asphalt and oil, which fills about seven-eighths of the volume of the case. Fire re-

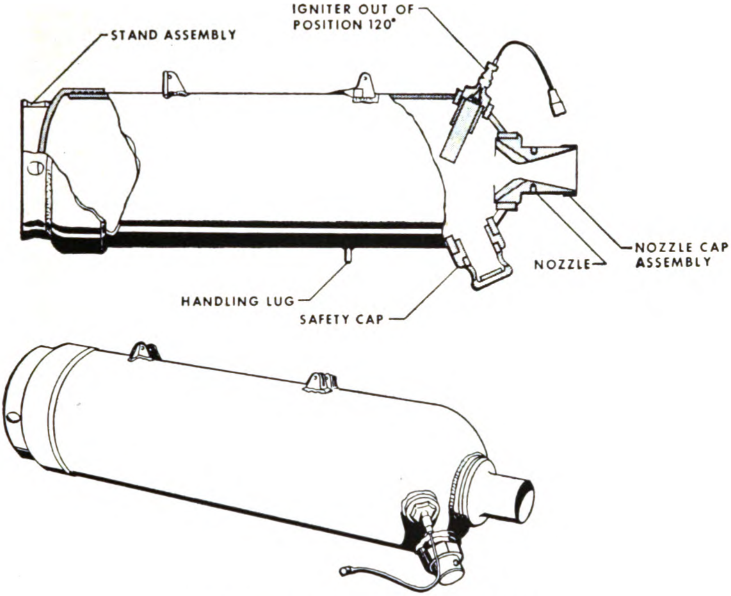


Figure 6–17.—14 AS 1000 JATO unit.

sistant tape completely surrounds the propellant charge and is used to control its burning, as inhibitor strips are used in rocket motors. Smokeless powder is used as the propellant in the newer **JATO 15 KS** 1000, which does not produce smoke or deposits as a result of combustion.

JATO Mk 2 Mod 3 (14 **AS** 1000) weighs about 200 pounds when completely assembled.

JATO 15 **KS** 1000 weighs 143 pounds and delivers its rated 1,000-pound thrust for 15 seconds instead of for 14 as the older unit does.

Loading

JATO units have three mounting lugs welded to the case for securing them to the aircraft. Two lugs are mounted side by side toward the nozzle or after end, with a single lug located forward. The mounting device on the airplane includes a latch which locks on the forward lug when the unit is loaded and which can be released from within the aircraft to jettison the unit after it has been fired. The two aft fittings serve to hold the unit firmly in place and are designed to absorb the full thrust load.

In all installations, contact between the "hot" side of the aircraft electrical system and the igniter is obtained by means of a single positive lead, connected to the igniter, which is "plugged in" to a ball terminal located on the airplane when ready for firing. After the units are loaded on the aircraft and BEFORE plugging in, the firing circuits must be checked for continuity and stray voltage, in much the same manner that rocket circuits are tested. However only one test device is required.

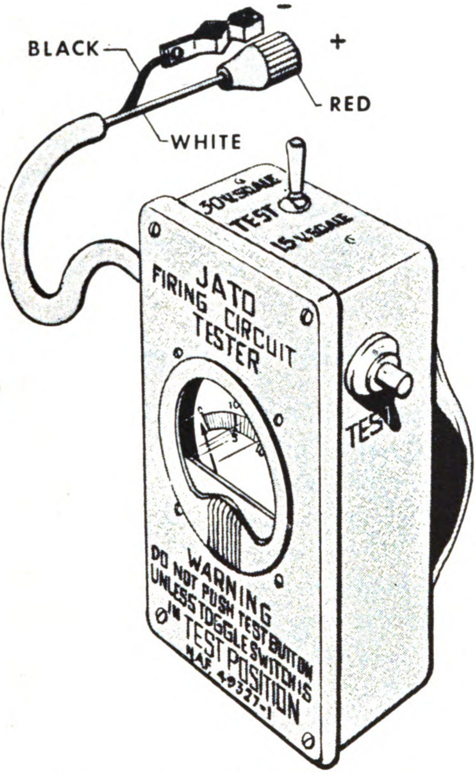
A three-man loading crew is required, one of whom must have a Firing Circuit Tester (fig. 6–18). Two models are available, NAF 49327–1 and a new model whose part number is NAF 49390–1. The newer type will also indicate, by a partial reading during the full voltage test, a "near break" or "weak link" in the circuit, but operation of both types is identical, as described below.

After the JATO units are brought to the aircraft, the loading crew secures them to the aircraft. Each unit is attached to its three suspension lugs and then shaken to make sure it is locked in place. Igniters should not yet be installed but if they are, DO NOT connect the leads.

Check the test meter by placing the toggle switch on the top of the meter in the neutral or test position and press the "TEST" button on the side. The meter is provided with a small 1.5-volt battery for this purpose, and if the meter indicates voltage (according to the condition of the dry cell), it is safe to proceed with the aircraft circuit check.

Either the pilot or a crewman should turn on the battery switch AFTER MAKING CERTAIN NO IGNITERS ARE CONNECTED and then throw on all JATO switches. The JATO firing switches are held down while the man with the circuit tester checks each unit terminal. To do this, the red terminal of the tester (fig. 6–18) is connected to the positive (+) ball terminal on the airplane and the clamp, or negative (−) terminal, is connected to the JATO unit. BE CERTAIN NO UNIT IGNITER

LEAD (IF ALREADY INSTALLED) IS CONNECTED BEFORE MAKING THIS TEST. If the test is made before the JATO units are loaded on the plane, the clamp should be connected to the skin of the aircraft. Next, throw the toggle switch on the top of the tester toward the side marked "30-volt scale." The meter should read 24 to 28 volts if the circuit is in proper order.



−
+
BLACK
RED
WHITE
30 V. SCALE
TEST
15 V. SCALE
JATO FIRING CIRCUIT TESTER
WARNING
DO NOT PUSH TEST BUTTON UNLESS TOGGLE SWITCH IS IN TEST POSITION
NAF. 49327-1
TEST

Figure 6–18.—JATO Firing Circuit Tester.

Upon completion of the high voltage check, the testing man should call for all switches off and proceed to check each unit terminal for no voltage by holding the toggle switch to the 1.5 volt scale. THERE SHOULD BE NO VOLTAGE READING. Do not under any circumstances connect an igniter to a circuit that gives a voltage reading during this test; as little as one volt will cause operation of the igniter in 10 to 15 seconds. Cell action set up by salt spray on unclean terminals will occasionally generate enough voltage to indicate on the meter. Should this occur all terminals and cable joints in the circuit should be cleaned as well as checked for a short circuit in the JATO wiring to a live circuit. Recheck the circuit to be sure the trouble is remedied before use.

After all circuits have been tested and a check made to insure that all switches are off, igniters may be installed. The metal nozzle caps used in shipping and storage should be removed and the igniter leads connected to the ball terminal on the airplane. It is advisable to twist the connector back and forth on the ball terminal a few times to insure a good connection. Do NOT stand behind a unit when connecting the igniter lead. The unit is now ready to be fired when the pilot wishes.

Stowage and Handling

JATO shall be stowed separately from all other types of ammunition and explosives. When ashore, JATO shall be stowed as bomb type ammunition in approved, barricaded, earth covered, high explosives magazines.

14 AS 1000 JATO units must be stowed, handled, and transported with the nozzle end up. This is especially important at higher temperatures as the propellant has a tendency to soften and flow. If the propellant flows, the burning area is increased, resulting in excessive pressure when ignited.

Stowage temperatures must be within the range stenciled on the case.

JATO igniters shall be stowed separate from the units and preferably by themselves in a fuze or detonator locker or magazine. The igniter stowage shall not be within five feet of radio apparatus or antenna leads.

JATO units shall be inspected prior to use and any of the discrepancies listed below is sufficient to consider the unit unserviceable:

1. Nozzle.
   - a. Exit cone (venturi) bent or deformed.
   - b. Obstructions present.
2. Safety disk or diaphragm—not intact.
3. Case.
   - a. Excessive rusting or corrosion.
   - b. Evidence of damage due to rough handling.
   - c. Suspension lugs damaged.
   - d. Broken welds.
   - e. Thrust pins loose in suspension lugs.
4. Igniter.
   - a. Rusted electrical connectors.
   - b. Broken plastic powder container.
   - c. Moisture inside igniter body.
   - d. Steel collar (which secures plastic container to rest of igniter) loose.

Safety Precautions

JATO units must not be dropped, tumbled, rolled, or dragged. Units that have been subjected to any of the following conditions must be clearly marked "UNSAFE FOR USE" and disposed of in accordance with current instructions:

1. Held in a horizontal position for more than 75 hours. This time is cumulative.

2. Exposed for more than one hour to temperatures outside the range specified on the case.

3. Subjected to rough handling.

4. Dropped nozzle end down from any height.

5. Fallen or knocked over from the vertical position.

6. Dropped from a height in excess of 12 inches in any attitude other than that given in (4) and (5) above.

Under any of these conditions, the unit is perfectly safe to handle but would be dangerous if fired.

JATO should not be subjected to gunfire or intense heat.

Storage life of units is determined by the Bureau of Ordnance. The same agency issues instructions for the disposition of overage units.

Never install the igniter in a JATO unit unless the unit is immediately ready for firing or in the firing position. Never connect an igniter lead before checking to make sure all JATO switches are OFF and performing a no-voltage test.

In case of a safety disk blow, JATO units will burn and smoke for approximately 10 minutes time. No attempt should be made to extinguish this flame as it is impossible and no detrimental result will follow if the unit is allowed to burn itself out.

Upon removing the igniter shipping plug, an inspection should be made to determine that no foreign matter or moisture is in the combustion chamber, and that propellant is not cracked or damaged.

Before firing units, make sure the nozzle caps have been removed.

QUIZ

1. The caliber of a rocket is determined by the diameter of the __________.
2. What explosive is used in most rocket motor igniters?
3. Rocket fuzes are assigned numbers in the __________ series.
4. TRUE OR FALSE: Base fuzes should be removed for inspection periodically.
5. The standard impact-firing rocket nose fuze is the __________.
6. Base fuzes are armed by a combination of __________ __________, ________, and __________.
7. The letters SCAR are an abbreviation of __________ __________ __________.
8. The 5-inch GP aircraft rockets that utilize the 3.25-inch motor have a velocity of ______ f. p. s.
9. The 5-inch HVAR's use (1) __________ for a propellant and have a velocity of (2) ______ f. p. s.
10. Antitank HVAR heads are filled with (1) __________ explosive and use the (2) "__________ Effect" to penetrate heavy armor with a stream of gas and molten metal.
11. The 11.75-inch Tiny Tim is ignited by means of a __________ firing device.

12. The 2.75-inch FFAR Mighty Mouse is primarily an air-to-______ rocket.

13. High-explosive rocket heads are painted (1) __________ with markings in (2) __________.

14. Before loading rockets, a (1) __________ test must be made on the aircraft rocket firing circuits. Before plugging in the pigtails, a (2) __________ test must be made.

15. How many Fahnestock clips are used on the arming wire of a Mk 172 VT fuze?

16. In what position must JATO units be stowed?

17. What two tests must be made before connecting a JATO igniter lead to the aircraft JATO firing circuit?

CHAPTER 7

PYROTECHNICS AND SMOKE SCREEN EQUIPMENT

PYROTECHNICS

Pyrotechnics can be described as "fireworks adapted to military use." Pyrotechny is literally "the art of fire"; hence pyrotechnics are those items which produce their effect by burning, and are consumed in the process.

Aircraft pyrotechnics consist of mixtures of combustible elements and oxidizing agents in containers designed for carrying in aircraft. When the containers are discharged or released, the contents are ignited. The resulting smoke, flame, or flash serves a SIGNALING, MARKING, or ILLUMINATING purpose. Dye or slick markers, though not in conformance with the above definitions, are classed as pyrotechnic munitions.

These important types of airborne munitions are used in a large variety of combat and rescue operations. Successful combat operations by aircraft squadrons and by individual aircraft depend heavily upon the reliability and proper functioning of pyrotechnics used for recognition and identification. Target identification and illumination are essential to successful reconnaissance, photography, and attack.

The discovery and recognition of downed airmen, or other personnel in distress, depend largely upon pyrotechnic signals or dye markers. Drift signals aid in determining the course and drift of aircraft, and may be indispensable when communications are disrupted. Drift signals and float lights are very useful markers, wind indicators, and reference points.

The earliest pyrotechnic compositions consisted of varying mixtures of the constituents of black powder: charcoal, sulphur, and saltpeter. Other materials were added to produce special effects, such as iron filings and coarse charcoal. Many other materials were added or substituted as the art and uses of pyrotechnics progressed.

STANDARD PYROTECHNIC COMPOSITIONS consist, in general, of mixtures of the following substances:

1. Compounds to provide oxygen (oxidizers) for burning.
2. Fuels.
3. Binding and waterproofing agents.
4. Color intensifiers.

In some cases, a single material may serve for more than one of the functions listed above.

A FRICTION IGNITER consists of a primer cup containing a mixture of potassium chlorate, charcoal, and a dextrin binder. A loop of wire coated with red phosphorus in shellac extends through this cup. When the wire is pulled through the cup, the priming mixture is ignited.

QUICKMATCH is a term applied to strands of cotton soaked in a mixture of black powder and gum arabic and coated over with mealed black powder. It transmits flame to igniting, priming, or pyrotechnic charges.

The PRIMING CHARGE is a dried paste of black powder in close contact with the first-fire composition.

The FIRST-FIRE COMPOSITION is generally a mixture of illuminant charge and black powder. However, for certain items it may be a special, easily ignited composition with high-burning temperature.

Pyrotechnic items usually function by means of an ignition train corresponding to the explosive train in high-explosive munitions. The ignition train may be composed of a primer, a delay element, and a composition or series of compositions which intensify the heat in order to assure proper combustion of the pyrotechnic candle.

All aircraft pyrotechnics are issued as complete rounds, except for certain flares and photoflash bombs which must be fuzed at the time they are loaded on the aircraft, and not before.

The effectiveness of most pyrotechnic munitions depends upon the visibility resulting from the flame, flash, or smoke. Visibility, in turn, is affected by the design of the pyrotechnic, by the position of the effect relative to the observer, and by the prevailing atmospheric conditions. Almost any desired characteristic—such as candlepower, color of light or smoke, and burning time—may be obtained by variations in components.

The actual visibility of a given pyrotechnic also is affected by such factors as the color and reflective qualities of the background, the distance from the observer, the relative position, the angle of observation, and the degree of natural illumination.

ILLUMINATING PYROTECHNICS

Aircraft Parachute Flares

All Navy-type aircraft parachute flares consist of a chipboard casing with its ends closed by disks, within which are packed the following items: a parachute and shroud lines; an illuminant; a friction igniter, and/or fuze for igniting the illuminant; and the required accessories, including a support band to be attached when the flare is to be suspended from a bomb rack.

All Navy-type aircraft flares have a ripcord, or firing lanyard, one end of which is attached to the aircraft, the other serving to initiate the parachute action or fuze action as the flare drops away from the plane. In most service flares, some type of delay fuze is utilized to predetermine the distance below the aircraft at which burning is to be initiated.

According to their manner of functioning, flares are grouped into two general classes, as described below.

Flares of the first type are designed for immediate parachute opening and illuminant ignition as soon as they are clear of the launching aircraft. After falling a distance of 3 to 5 feet, the casing is opened by the ripcord, the parachute is opened, and the illuminant ignited by means of a friction igniter actuated by the parachute shroud lines. Some flares of this type have the ignition of the illuminant delayed for a period of 90 to 180 seconds after the opening of the parachute.

Flares of the second class are designed to fall a predetermined distance below the launching aircraft before functioning. This is accomplished by means of a variable time delay fuze on one end of the flare; the fuze is actuated by a ripcord upon release and after a VERTICAL fall corresponding to the fuze setting, the fuze functions, opening the parachute and igniting the illuminant. The delay in functioning can generally be varied from 300 feet to 12,000 feet vertical distance below the launching aircraft.

Aircraft Parachute Flare Mk 4 and Mods

This flare is used primarily for illuminating a large area sufficiently to permit the landing of aircraft. It may also be used to illuminate an area for reconnaissance and bombing. However, Aircraft Parachute Flares Mk 5, Mk 6, and Mk 10, having much greater candlepower than Aircraft Parachute Flare Mk 4, are more satisfactory for reconnaissance and bombing. Aircraft Parachute Flare Mk 4 and Mods has also been used by low flying aircraft to blind the enemy's antiaircraft defenses. This is effective only against visually aimed antiaircraft guns, of course.

The complete flare, as issued ready for release, weighs approximately 18 pounds. The shellac-impregnated chipboard case has a diameter of 4¾ inches and a length of 27⅜ inches. Two metal steadying bands are fastened to the case, against which rest the sway braces of the bomb rack.

The Mk 4 and Mods is an immediate-functioning type flare. Full ignition and suspension occur about 30 to 50 feet below the launching plane and the flare burns approximately 3 minutes with a light intensity of about 300,000 candlepower.

OPERATION (refer to fig. 7–1).—When the flare is released from the aircraft, the arming plate on the end of the ripcord is retained by the arming hook of the rack or shackle, or by the bomb arming control. The ripcord (fastened to the arming plate) tears along the side of the case until it reaches the end of the flare casing. As the flare continues to fall,

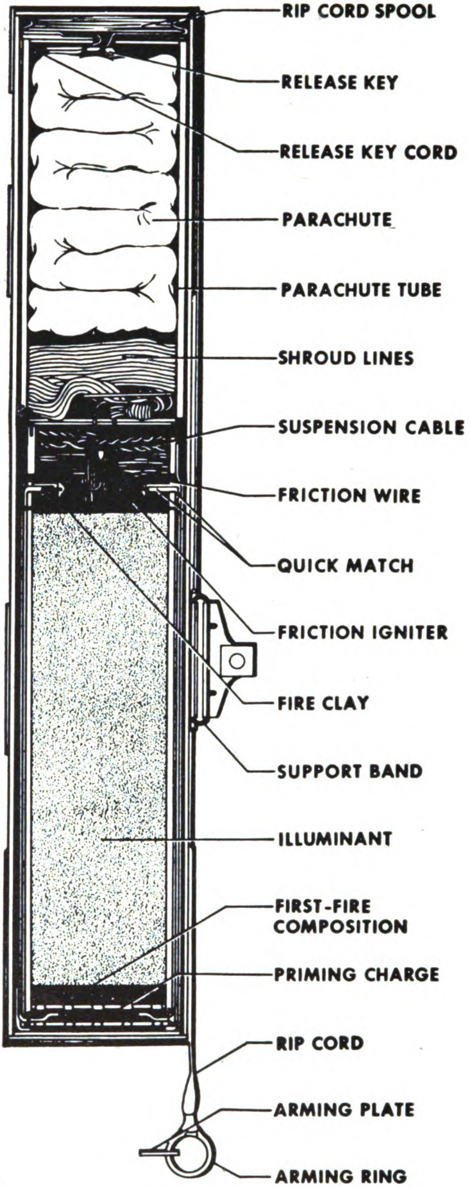


Figure 7–1.—Aircraft Parachute Flare Mk 4 and Mods.

the ripcord, which is wound around a wooden spool inside the end of the case, unwinds from the spool, thus carrying away the end of the case. When the end of the flare case is torn away, the ripcord pulls the wooden spool and the parachute tube (with parachute inside) out of the flare case. The spool falls away. The tension on the ripcord retains the parachute tube; as the flare case containing the illuminant candle falls away, the parachute is pulled out of the lower end of the parachute tube by the suspension cable and the parachute shroud lines.

When the parachute and parachute shrouds are fully extended, the release key cord becomes taut and pulls one end of the release key down and away from the chipboard cover of the parachute tube. This allows the ripcord to slip through the key and become detached from the parachute tube.

An ignition wire is attached to the suspension cable in such a manner that it is pulled before the suspension cable is fully extended. The ignition wire pulls four friction wires through primer cups of match compound. This ignites a double quickmatch which burns down the outside of the illuminant case and ignites the priming charge, then the first-fire composition, which, in turn, ignites the illuminant composition.

The parachute opens and suspends the flare, and the parachute tube falls free.

The proper altitude for the release of this type of flare depends upon the purpose for which it is to be used. For purposes of observation or reconnaissance the flare should be released at altitudes of between 1,500 to 5,000 feet, depending upon the area to be observed. This flare should never be released over friendly territory at altitudes of less than 1,500 feet, except in cases of extreme emergency. The flare falls approximately 450 feet per minute, and since it burns about 3 minutes, would likely reach the ground before burning is completed.

Caution: This flare should not be launched from bomb bays. Because of its quick opening, the parachute may foul the aircraft structure. Aircraft Parachute Flare Mk 4 Mod 1 is restricted to TRAINING USE ONLY.

The Aircraft Parachute Flare Mk 4 and Mods is shipped in a moisture-proof metal container, six containers in one wooden packing box. The flares should be stowed in the original containers in a location where the temperature does not exceed 100° Fahrenheit. If this temperature is not exceeded, satisfactory performance can be expected for 6 to 10 years after the date of manufacture.

Aircraft Parachute Flare Mk 5 and Mods

The Mk 5 and Mods is used to illuminate a large area sufficiently to permit reconnaissance, bombing, or the landing of aircraft. It also has a blinding effect on antiaircraft gun crews.

Aircraft Parachute Flares Mk 5 Mods 0, 1, and 2 are restricted to training use only. Mods 3 and later are for service use, subject to subsequent BuOrd restrictions.

The complete flare, as issued ready for release, weighs approximately 18 pounds. The shellac-impregnated chipboard case has a diameter of 4¾ inches and a length of 27 inches. Two metal steadying bands are fastened to the case, against which rest the sway braces of the bomb rack.

The Mk 5 and Mods uses a variable time delay fuze to provide a delayed functioning time (fig. 7–2). The setting is made by turning the lock screw on the metal firing mechanism to the desired delay. The delay is shown on the fuze setting ring, and indicates the vertical distance the flare will drop before igniting. This distance (or delay) can be varied from 300 feet to 12,000 feet. Thus if the launching aircraft is to fly at 9,000 feet altitude and flare ignition is desired at 2,000 feet altitude, the fuze should be set at "7M" (7,000). The flare will then fall 7,000 feet before igniting.

Caution: The fuzes of Aircraft Parachute Flares Mk 5 Mods 8 and 9 have a safety screw which MUST be removed after the flare is installed on the bomb rack or shackle. The flare will not function if this safety screw is not removed.

The flare burns about 3 minutes at a light intensity of

600,000 candlepower, and falls approximately 1,500 to 1,800 feet while burning. A yellow light is produced by the Mk 5 Mod 3 and later flares.

The fuze end of the case is closed by a metal cover. The parachute end of the case is closed by several layers of chipboard held in place by gummed cloth and sealed with paraffin. The flare, as issued, is water-repellant but should be kept in its moisture-proof container when not installed in a plane. Markings on the case show where to attach the support bands when the flare is to be released from a bomb rack or shackle. The support bands are shipped in the packing box with the flares.

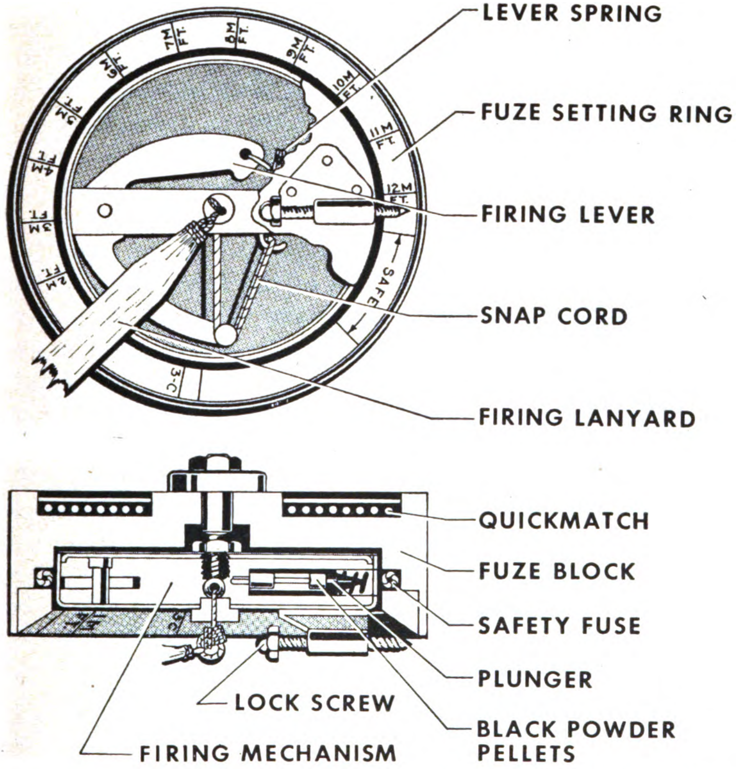


Figure 7–2.—Fuze for Aircraft Parachute Flares Mk 5 and Mods, Mk 6 and Mods, and Mk 10 Mod 0.

Operation (refer to fig. 7–3).—When the flare is released from the aircraft, the arming plate on the end of the firing lanyard is retained by the rack, shackle, or arming control. The firing lanyard tears along the side of the case, flips off the fuze end cover, and pulls the snap cord attached to the firing lever (fig. 7–2).

The fuze mechanism of the Mk 5 Mods 0 to 7 functions as follows:

The weight of the flare pulls the firing lever away from the primer until the snap cord becomes taut, at which time the snap cord breaks. The firing lever spring then drives the firing lever back against the fulminate of mercury primer. The flame from the primer ignites the black powder pellets in the fuze plunger, and the expanding gases from the black powder force the sharp point of the plunger outward into the safety fuse. Three small holes near the point of the plunger allow some of the flame to escape from the inside of the plunger into the powder of the safety fuse, which commences to burn at the rate of 12 inches per minute. It can be seen that the point at which the fuse commences to burn is determined by the drop desired before flare ignition, and is regulated by the position of the fuze lock screw on the fuze mechanism; as the lock screw is turned to the altitude desired, the plunger beneath it is rotated accordingly.

The fuze mechanism of the Mk 5 Mods 8 and later is similar except that the cord pulls away from the firing lever instead of breaking, thus requiring much less pull to fire the primer. A pull of only 8 pounds is required to operate the firing lever instead of a pull of approximately 38 pounds required in the earlier models (Mods 0 through 7). Because of the amount of pull required to operate the earlier types, they are not suitable for launching from a bomb bay. Air currents entering the open bomb bay tend to reduce the stress on the snap cord, with the result that the cord does not break and the flare remains suspended from the firing lanyard. The Mk 5 Mods 8 and later flares can be safely launched from bomb bays.

After the safety fuse burns its predetermined length, it

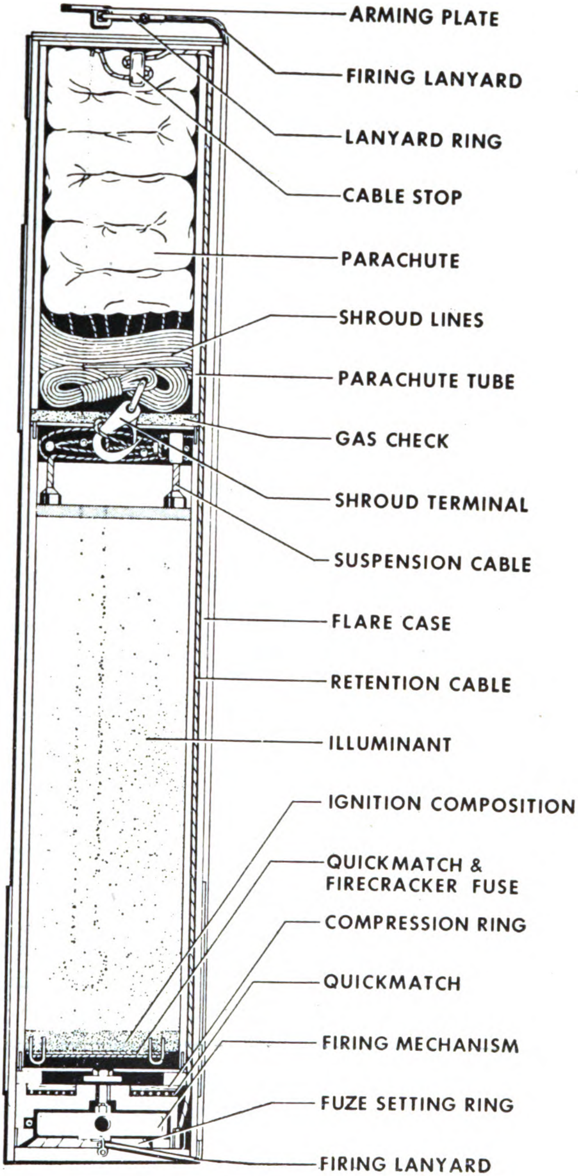


Figure 7–3.—Aircraft Parachute Flare Mk 5 and Mods.

ignites the quickmatch under the fuze block. This in turn ignites the quickmatch and firecracker fuse stapled to the ignition (or first-fire) composition.

When the ignition composition begins to burn, the gases generated force the parachute and illuminant out of the flare case. The parachute opens and the parachute shroud terminal on the end of the shroud lines slides up the retention cable until it is stopped by the cable stop. A short length of cable beyond the cable stop suspends the flare case well away from the burning flare and keeps the case from dropping as a missile hazard (Mk 5 Mods 0 to 7). The flare case of Mods 8 and later is not retained but drops free.

The Aircraft Parachute Flare Mk 5 and Mods is shipped in a moisture-proof metal container, six containers in one wooden packing box. If stowed in temperatures less than 100° Fahrenheit, satisfactory performance can be expected for 6 to 10 years after the date of manufacture.

Aircraft Parachute Flare Mk 6 and Mods

The Mk 6 and Mods is a high-intensity flare designed to illuminate an area for bombing and reconnaissance. Mk 6 Mods 3 and later are for service use; earlier Mods are unserviceable. The flare can be launched from a bomb rack or shackle, a flare container, or by hand.

The complete flare, as issued ready for release, weighs approximately 30 pounds. The shellac-impregnated chipboard case, which contains a time fuze, a parachute, a small auxiliary parachute, and the illuminant candle, is 5⅜ inches in diameter and 35¾ inches long.

The time fuze is the same as that used in the Aircraft Parachute Flare Mk 5 and Mods (fig. 7–2), and fuze setting and functioning procedures are identical. The Mk 6 Mods 3 and 4 have the older type fuze which requires about 38 pounds of pull to break the snap cord. Mods 5 and later have fuzes which require only about 8 pounds of pull to function, since the snap cord pulls away from the firing lever instead of breaking. The Mods 5 and later also have a safety screw in the fuze body which must be removed after the flare is installed in the plane.

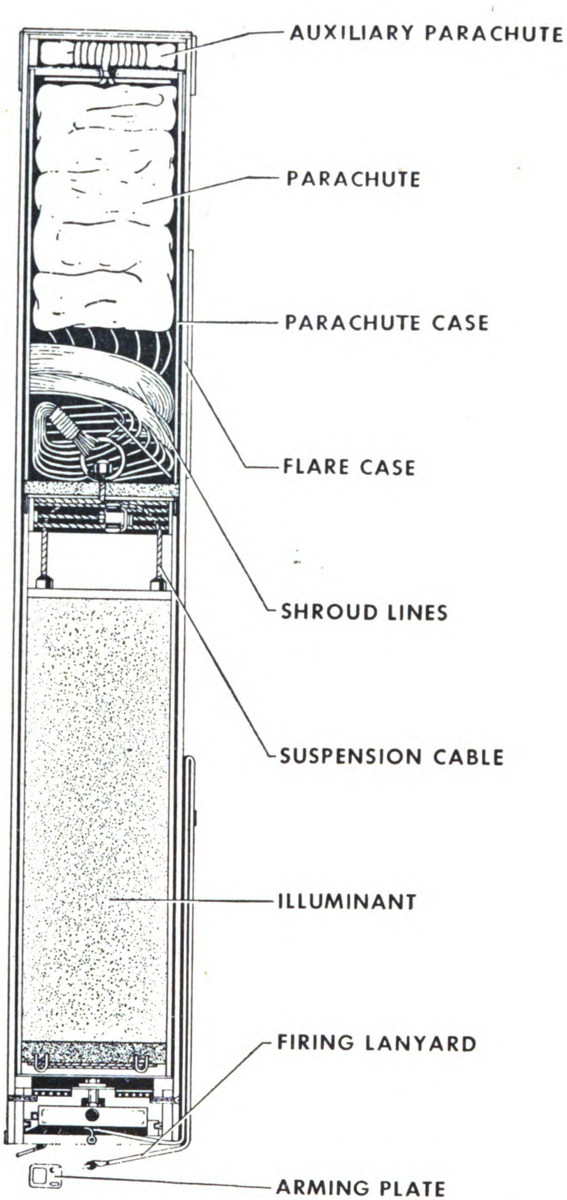


Figure 7–4.—Aircraft Parachute Flare Mk 6 and Mods.

The parachute is connected to the illuminant candle by a steel suspension cable (fig. 7–4). The flare burns approximately 3 minutes and produces a pale yellow light of 1,000,000 candlepower intensity. It falls about 1,500 feet while burning.

OPERATION (refer to fig. 7–4).—When the flare is released, the arming plate on the end of the firing lanyard is retained by the bomb rack, shackle, or arming control. The firing lanyard tears along the side of the case, flips off the metal fuze end cover, and pulls the snap cord attached to the firing lever.

Functioning of the fuze has been described previously; it ignites the first-fire composition at the bottom of the illuminant candle.

When this composition begins to burn, the gases generated force the auxiliary parachute, the main parachute in its case, and the illuminant out of the flare case, which falls clear. The auxiliary parachute opens and retards the main parachute in its case, allowing the illuminant to pull the shroud cords and parachute out of the parachute case for full suspension of the flare.

Aircraft Parachute Flares Mk 6 and Mods are packed separately in moisture-proof metal containers, four containers in one wooden packing box. The flares should be stowed in their original containers in a location where the temperature will not exceed 100° Fahrenheit. If this temperature is not exceeded, satisfactory performance can be expected for 6 to 10 years after the date of manufacture.

Aircraft Parachute Flare AN–Mk 8 Mods 1 and 2

This flare was developed specifically for night antisubmarine warfare. The AN–Mk 8 Mods 1 and 2 is an immediate opening, delayed-ignition type designed to allow a patrol plane to drop the flare near a target and then get into position to attack before the illuminant candle ignites. The AN–Mk 8 Mod 1 incorporates a 90-second delay while the AN–Mk 8 Mod 2 incorporates a 120-second delay. The flare can be launched from bomb racks or externally mounted shackles,

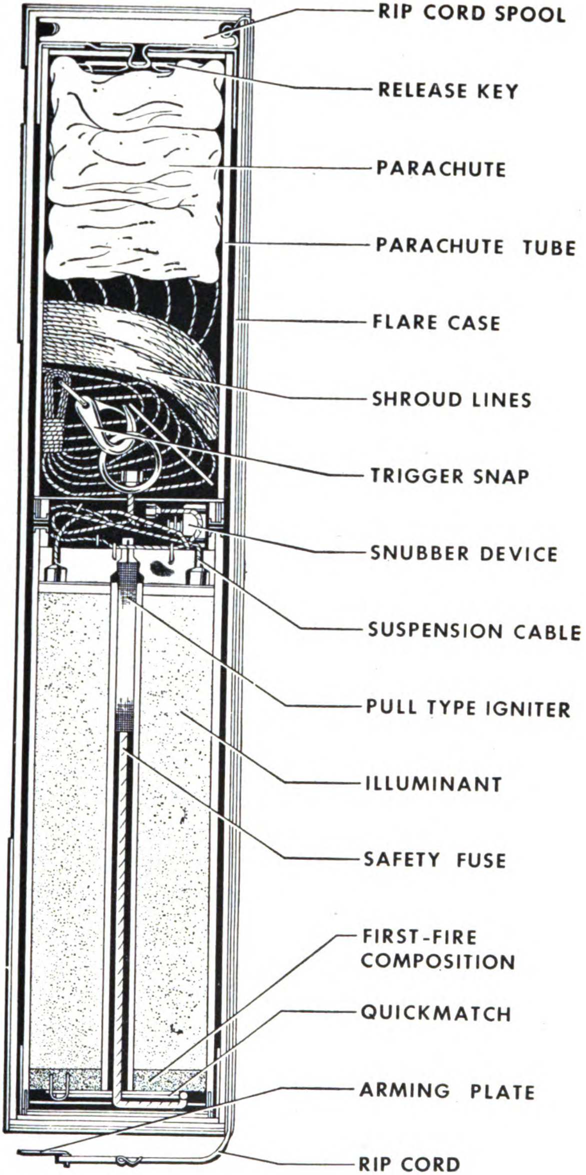


Figure 7–5.—Aircraft Parachute Flare AN–Mk 8 and Mods.

flare tubes, or by hand. It cannot be launched from bomb bays as the quick-opening parachute may foul on the aircraft structure.

The complete flare, as issued ready for release, weighs approximately 18 pounds. The shellac-impregnated chipboard case has a diameter of 4¾ inches and a length of 25⅛ inches.

The AN–Mk 8 Mods 1 and 2 burn approximately 3 minutes, producing a pale yellow light with an intensity of about 500,000 candlepower. The minimum altitude from which these flares may be dropped and obtain full burning time is 2,500 feet. Mods 1 and 2 can be launched at air speeds up to 220 knots without danger of damage to the parachute.

OPERATION (refer to fig. 7–5).—The suspension of the flare from its parachute is accomplished in the same manner as that already described for the Mk 4 and Mods, except that part of the opening shock is taken up by the snubber device at the lower end of the suspension cable.

As the suspension cable becomes taut, it pulls upward on the pull type igniter which is located in a tube in the center of the illuminant candle. This causes the igniter to function, which ignites the safety fuse. The safety fuse burns either 90 or 120 seconds (depending upon Mod) and then ignites the quickmatch and first-fire composition successsively, which in turn ignites the illuminant composition.

Aircraft Parachute Flare Mk 8 and Mods is shipped in a moisture-proof metal container, six containers in one wooden box. Storage requirements are the same as for flares already described.

PYROTECHNIC BOMBS

Photoflash Bomb AN–M46

This bomb produces a light of high intensity and short duration for night photography. Bomb Nose Fuze (Mechanical Time) AN–M146 permits its use for high altitude photography. The bomb produces a flash of 0.20-second duration with an average intensity of 500 million (500,-

000,000) candlepower and a peak intensity of 800 million (800,000,000) candlepower.

The bomb, ready for release and including a 25-pound charge of flash powder, weighs 52 pounds. It has a diameter of 8 inches and a length of 48⅝ inches. The body, or case, is thin gage steel and a threaded steel adapter in the nose section accommodates the fuze. The adapter contains, at its base, a metal cup filled with 145 grains of black powder, which serves as a booster charge to ignite the flash powder. The fuze adapter is closed with a shipping plug during shipment and stowage.

The AN–M46 resembles a conventional bomb (fig. 7–6). It is unfuzed as issued, but fins and suspension bands are attached. A full-size trail or drag plate covers the entire area of the rear of the fin assembly, and for many types of photographic work this drag plate produces too much trail in the bomb when dropped. Modifications of the drag plate are authorized but must be done in accordance with instructions in Ordnance Pamphlet 998 (Second Revision) or other current BuOrd instructions. The best altitudes for release are from 7,500 feet to 25,000 feet, using the appropriate setting of the nose time fuze.

Operation.—The AN–M46 can be released only from bomb racks or shackles. If the bomb is released safe, it may function on impact and for this reason should never be jettisoned over friendly territory. When released armed, it functions as follows:

As the bomb falls away, the arming wire is withdrawn, allowing the arming vane to rotate and the arming pin to be ejected. When the set time has elapsed, the fuze functions, igniting in turn the black powder booster and the main charge of flash powder.

In preparing the bomb for loading, the AN–M146 nose fuze should be screwed into the fuze adapter handtight and then set for the desired time delay. The arming wire, which is shipped with the bomb, should be run through the forward suspension lug, the arming pin, and the arming wire guide and vane lock. No Fahnestock clip is used as the spring-loaded arming pin holds the arming wire firmly in place until armed release. AFTER the arming wire is installed, the safety cotter pin is removed from the arming pin and seal wire from the vane lock.

Photoflash Bomb AN–M46 is packed one to a wirebound

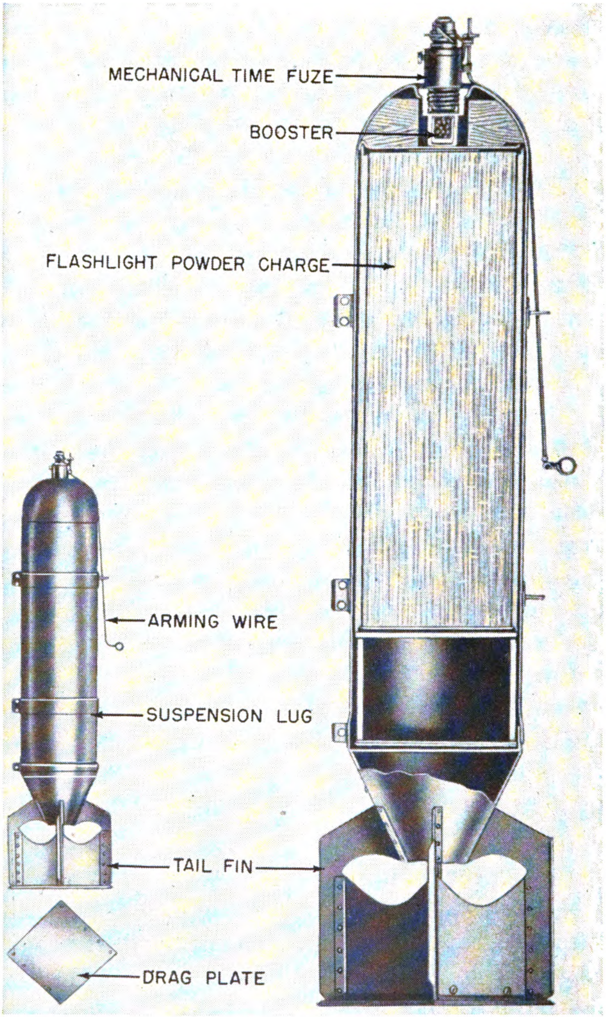


Figure 7–6.—Photoflash Bomb AN–M46.

wooden box. Suspension bands are assembled to the bomb, but are removable. Fuzes are shipped separately.

SPECIAL SAFETY PRECAUTIONS: Flash powder, with which these bombs are loaded, is easily ignited by shocks, sparks, or friction. When ignited, photoflash bombs explode with extreme violence and intense heat. They must be handled with the same care as black powder and with EVEN GREATER care than ordinary pyrotechnic materials and conventional bombs.

Bomb cases should not be hammered or cut. Do not attempt to disassemble a photoflash bomb; it is EXTREMELY dangerous. No work should be done on these bombs except unpacking, fuzing, modifying the drag plate, subject to the conditions previously noted, and installing them on aircraft.

Because of the brilliance of the flash, it is detrimental to the vision to watch the explosion of photoflash bombs.

SIGNALING PYROTECHNICS—IDENTIFICATION SIGNALS

Aircraft Signal Cartridges

Signal cartridges are fired in the Pyrotechnic Pistol AN–M8 as a method of identification for and communication between aircraft and surface vessels. These signals can be seen during the day or night. They are manufactured for the Air Force and procured by the Navy from that service. Following is an example of the correct nomenclature for a cartridge-type identification signal used by the Navy:

SIGNAL, AIRCRAFT, RED TRACER, GREEN-RED DOUBLE STAR, AN–M58A1.

Aircraft signals project one or two free stars of the same or different colors; colors in current use are red, yellow, and green. All aircraft signal cartridges weigh from 4 to 6 ounces, are approximately 1½ inches in diameter, and between 3 and 3⅞ inches in length. Table 7–1 shows all aircraft signals in current service use.

The standard signal cartridge consists of a one-piece extruded aluminum case with extracting rim, a percussion primer, a propellant charge of black powder, a steel closing cap, and the illuminant star or stars, together with suitable cushioning wads. Double-star signals have two star charges,

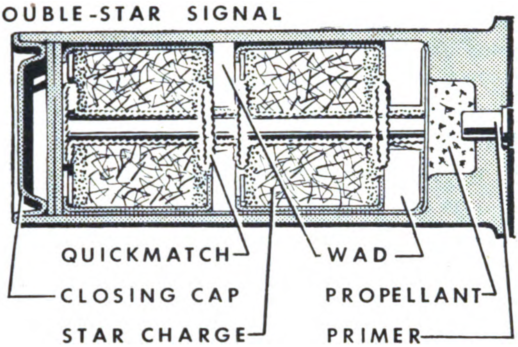
Table 7–1.—Aircraft signal cartridges.

Designation	Double or single star	Color combination
AN–M37A1	Double	Red-red.
AN–M38A1	Double	Yellow-yellow.
AN–M39A1	Double	Green-green.
AN–M40A1	Double	Red-yellow.
AN–M41A1	Double	Red-green.
AN–M42A1	Double	Green-yellow.
AN–M43A1	Single	Red.
AN–M44A1	Single	Yellow.
AN–M45A1	Single	Green.
AN–M53A1	Double	Yellow tracer, red-yellow star.
AN–M54A1	Double	Green tracer, red-red star.
AN–M55A1	Double	Green tracer, green-red star.
AN–M56A1	Double	Red tracer, green-green star.
AN–M57A1	Double	Red tracer, red-red star.
AN–M58A1	Double	Red tracer, green-red star.

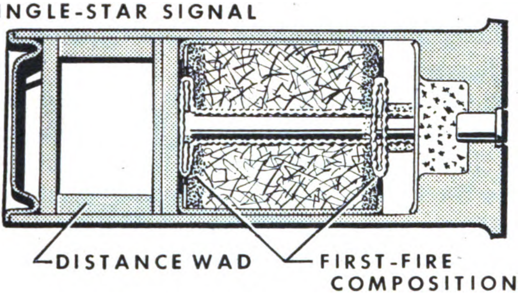
each in an aluminum case and tied together with quickmatch. Single-star signals have only one charge, of course, the empty space in the cartridge case being filled with spacer wads. Tracer-double-star rounds differ in having both star charges contained in one inner container which is closed at one end by the tracer composition. This inner container also contains a bursting charge of black powder to expel and separate the stars from the inner container at the proper time. Representative types of these signals are shown in figure 7–7.

Earlier types of aircraft signals, some of which may be encountered by the Aviation Ordnanceman, have a shotgun-type cartridge case of paper assembled to a brass head. These earlier types do not have the "A1" suffix in their designation, whereas all the metal-case signals are designated "A1."

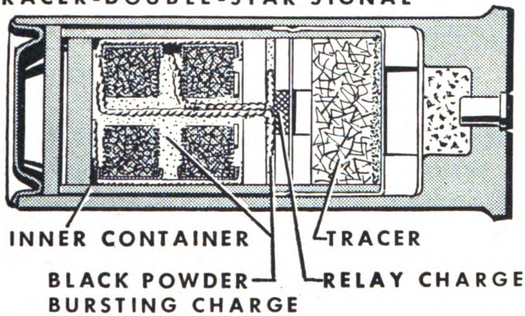
Colors of the star or stars in both types is indicated by one or two colored bands on the forward end of the case. Double-star signals have two ¼-inch bands, matching the color of the stars. Single-star signals have one ½-inch wide band, while tracer-double-star signals have one ¼-inch band in



DOUBLE-STAR SIGNAL



SINGLE-STAR SIGNAL



TRACER-DOUBLE-STAR SIGNAL

Figure 7–7.—Cutaway views of double-star, single-star, and tracer-double-star aircraft signals.

the color of the tracer and two ½-inch bands representing the star colors. The designation of the round and other information is stenciled on the case in black.

OPERATION.—All signal cartridges which do not contain tracers function as follows:

When the firing pin strikes the primer, the primer ignites the black powder propellant charge. As the star or stars are propelled from the case, the quickmatch is ignited by the burning gases, and in turn, ignites the first-fire compositions and stars. The stars reach full brilliance after traveling about 40 to 50 feet, and when fired from the ground reach a height of approximately 250 feet. The stars burn about 7 seconds and can be distinguished for 5 miles at night and from 2 to 3 miles in daylight.

Signal cartridges containing tracers function in a slightly different manner, as follows:

When the black powder propellant charge burns, it ignites the tracer in the inner container and expels the entire inner container, holding the two stars and the tracer, from the case. The tracer becomes visible after traveling about 20 feet. As the signal approaches the highest point of its trajectory (about 250 feet), the quickmatch connecting the two stars and the bursting charge are ignited by the tracer by means of a black powder relay charge. The two-star assemblies are ignited as they are expelled and separated from the inner container by the bursting charge.

The tracer burns about 4 seconds and the stars for about 4½ seconds. In effect, the tracer appears as a single star and rises to a height of 250 feet, when the star separates into two stars which fall separately. The tracer and stars can be seen for 5 miles at night and 2 to 3 miles in daylight.

Aircraft signal cartridges are packed 12 cartridges to a carton, 12 cartons to a wooden box. They must be stowed in magazines at temperatures of less than 100° Fahrenheit or rapid deterioration will occur.

Pyrotechnic Pistol AN–M8

With or without mount, the "pyro pistol," as it is often called, is standard equipment for naval aircraft, including training planes, and is used to fire the aircraft signals just described. The Mount M1 (fig. 7–9) attaches the pistol to the aircraft so that it may be fired through an opening in the fuselage. The pistol may be detached from the mount and fired while in the hand.

Pyrotechnic Pistol AN–M8 is a breech-loading double-action signal pistol. The barrel, hinged to the frame, is held in firing position by the breech lock. The plastic grips, back plate, and cover plate fasten to the aluminum frame and act as a housing for the firing mechanism. To load the pistol, lift up on the breech lock. This unlocks the breech and swings the breech up. Insert the round and close the breech.

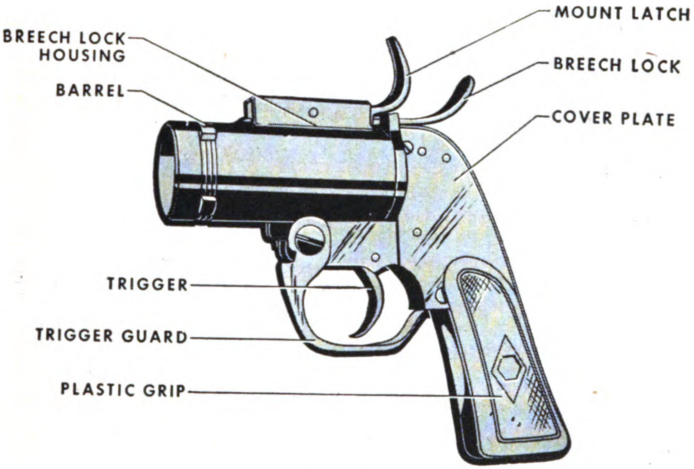


Figure 7–8.—Pyrotechnic Pistol AN–M8.

Caution: When loading and firing, care should be taken never to point the pistol toward other personnel or vessels. The star charges can inflict severe burns or easily start fires. When firing the pistol by hand, it should be held with the elbow slightly bent to absorb the shock of recoil.

The pistol must be kept in serviceable condition at all times. After each firing, it should be cleaned thoroughly and all principal parts wiped down with an oily cloth. When

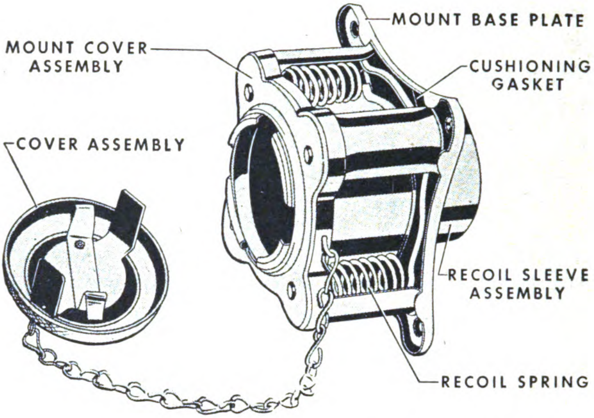


Figure 7–9.—Mount M1 for Pyrotechnic Pistol AN–M8.

assembled, the exposed parts should be wiped off with a dry cloth. To remove powder residue, the bore should be swabbed out with a cloth dampened with acetone or other approved solvent.

Aircraft Emergency Identification Signals Mk 6 and Mk 7

These signals are launched by hand as a method of identification for aircraft. The Mk 6 produces a colored star for use at night and the Mk 7 produces colored smoke for use in daylight.

The signals are contained in aluminum cylinders about 2½ inches in diameter. Signal (Star) Mk 6 is about 6 inches long and weighs 1⅜ pounds; Signal (Smoke) Mk 7 is about 10 inches long and weighs 2½ pounds. A grenade firing mechanism is screwed to one end of the case while the other end is closed by a metal cap.

Inside the case (fig. 7–10) are an ejection charge, a pyrotechnic candle, and a parachute made of silk, rayon, or paper. Both signals are essentially the same except for length and the composition of the pyrotechnic candle. The cylindrical surface of the case is marked to indicate the type and color of the signal. The closing cap or the star signal is embossed to indicate the color of the star contained: green, white, or red. The closing cap of the smoke signal is not embossed but is painted the approximate color of the smoke that will be produced.

OPERATION (refer to fig. 7–10).—Aircraft emergency identification signals are launched by hand from an aircraft in flight. The signal is held firmly in one hand, making sure the release lever is held against the body of the signal. A

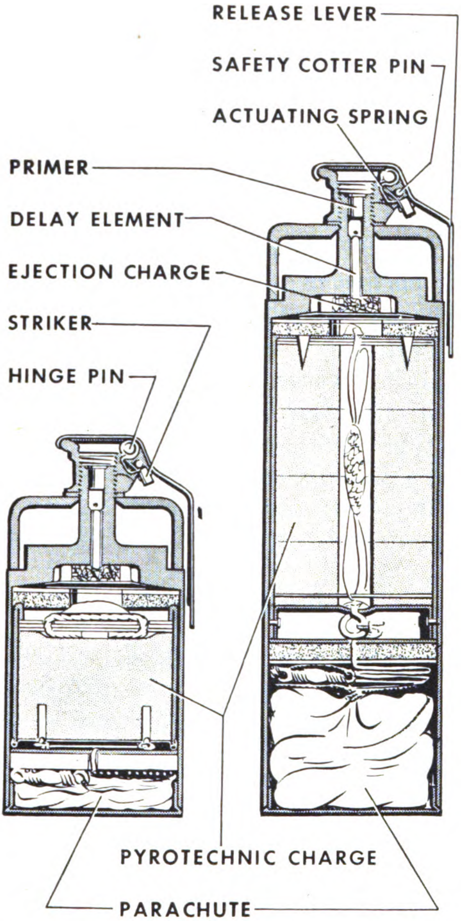


Figure 7–10.—Aircraft Emergency Identification Signals Mk 6 and Mk 7.

safety cotter pin, to which is attached a ring, secures the release lever to the firing mechanism. The safety ring and cotter pin are pulled out with the other hand and the signal launched over the side.

The release lever is forced off by the striker, which is at all times under tension of the striker actuating spring. The striker rotates about the hinge pin and strikes the primer. The primer ignites the delay element, which burns about 3 seconds and then ignites the ejection charge.

The gases produced by the burning ejection charge push out the closing cap, parachute, and pyrotechnic candle, and at the same time, ignite the starting mixture. The parachute opens and suspends the signal, which burns about 25 seconds. The stars can be seen about 8 to 10 miles, while the color of the smoke signals can be distinguished at a distance of 5,000 to 6,000 yards.

Caution: After removing the safety cotter pin, it is EXTREMELY important to hold the release lever firmly against the case of the signal until launched. Only a small movement of the lever is required to free the striker and initiate the ignition train. Never remove the firing mechanism.

Each signal is packed in a lightweight, moisture-proof, mailing tube type container. Twelve of these containers are packed in an unlined wooden box. The signals must be stowed in a dry, well-ventilated location and temperature should not be allowed to exceed 100° Fahrenheit.

Distress Signals

Distress signals for daytime use produce smoke while those for night use produce a light or star. Signals, flares, and other pyrotechnics, the primary use of which is for illuminating or marking, may also be used as distress signals.

Signal (Distress, Day and Night) Mk 13

The Signal Mk 13 is a combination distress signal for either day or night use and is particularly adapted for use by aviation personnel downed at sea. Because of its small size it can be conveniently carried in pockets of life jackets, flight suits, or life rafts. The signal consists of a metal cylindrical outer case $5\frac{1}{8}$ inches long and $1\frac{5}{8}$ inches in diameter, which contains an orange smoke mixture in one end and a flare pellet in the other. The signal weighs $6\frac{1}{2}$ ounces.

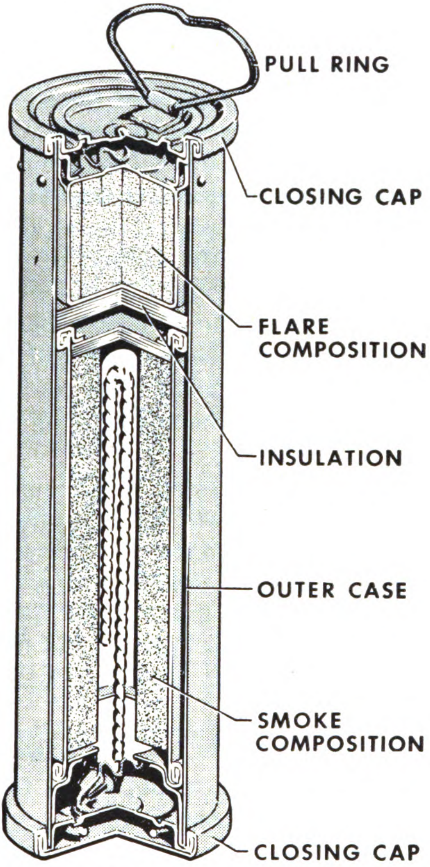


Figure 7–11.—Signal (Distress, Day and Night) Mk 13.

Both ends of the metal tube are closed by a soldered cap to which is attached a pull ring. Upon removal of the soldered cap (by pulling on the ring), a brass wire attached to the bottom is pulled through a friction igniter. This action results in igniting the smoke mixture or flare pellet, depending upon which ring is pulled. Smoke is produced for about 18 seconds; flare burning time is 18 to 20 seconds with an average intensity of 3,000 candlepower. The smoke can be seen up to 3 miles away, while the flare has an average visibility of 5 miles. Each section of the signal is waterproofed and insulated against heat transfer from one section to the other.

The soldered caps on both ends of the signal are covered with a paper cap to prevent accidental ignition. These paper caps should be removed before actual use so that the pull ring will be readily accessible when desired.

OPERATION.—The signal body carries an illustrated decalcomania showing in detail the method of operation. The flare end can be identified at night by the series of embossed projections which extend around the case about ¼ inch below the closure. Having determined which end of the signal is to be used, point the signal away from the face and give a quick pull on the pull ring, thereby igniting the pyrotechnic composition.

Hold the signal at arm's length at an angle of about 30° upward, to leeward, to prevent hot drippings or discharge from falling on the hand. After the pyrotechnic material has burned out, the signal should immediately be doused in the water in order to cool the metal parts. The signal should then be retained for use of the opposite end if required.

Caution: Never attempt to ignite both ends of the signal at the same time.

These signals are shipped in wooden boxes containing 100 signals. Stowage conditions required are the same as for other pyrotechnics already described.

Signal, Distress, Smoke, Hand, AN–Mk 1 Mod 1

The AN–Mk 1 Mod 1 distress signal is intended for use in life raft kits. It has a diameter of 1⅝ inches, a length of 3⅞ inches, and weighs 6 ounces. The signals contain a pyrotechnic mixture which produces orange smoke for about 18 seconds. One end of the case is closed by a soldered cap, to which is attached a pull ring used to fire the signal.

The AN–Mk 1 Mod 1 is similar to the Mk 13 signal in appearance, except that the AN–Mk 1 Mod 1 is shorter in length. The two signals function alike, and the instructions given for the Mk 13 apply also to the AN–Mk 1 Mod 1.

AN–Mk 1 Mod 1 distress signals are packed 100 to a wooden shipping case. They should be stowed in a cool dry place where the temperature does not exceed 100° Fahrenheit. The signals are watertight and are unaffected by moisture.

Signal, Distress, Two-Star, Red, AN–M75

This is a night, hand-held distress signal for use by aircraft personnel when forced down over water, and is small enough to be carried in the pockets of flight suits, life jackets, and life rafts. The case has a length of 5 inches, a diameter of $1\frac{1}{8}$ inches, and the signal weighs $5\frac{1}{2}$ ounces.

OPERATION (refer to fig. 7–12). Remove the screw-type cap and hold the signal in one hand with the igniter end pointed upward. Before attempting to fire the signal, unfold and fully extend the double-wire loops attached to the notched retainer fork. A twist of the assembly or a sharp pull at right angles to the case releases the spring-loaded firing pin activating the signal. After a delay of 2 to 4 seconds, the first star is ejected to a height of about 125 feet. Following a further delay of 2 to 4 seconds, the second star is ejected to the same height. The burning time of each star is from 4 to 6 seconds at a minimum intensity of 8,000 candlepower.

Caution: The ignition end of the signal should be aimed upward, to leeward, and away from the face and body. Do not look into the top of the signal. When the retainer fork is disengaged from the striker, the primer is ignited and this throws the igniter holder about 10 feet away from the signal.

Signals AN–M75 are packed 5 to a metal can, 16 metal cans in a wooden shipping box. Stowage requirements are the same as for other pyrotechnic items.

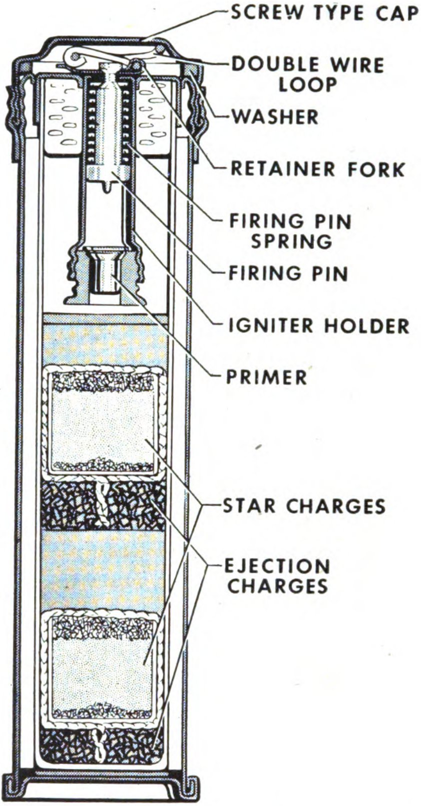


Figure 7–12.—Signal, Distress, Two-Star, Red, AN–M75.

PRACTICE BOMB SIGNALS

Miniature Practice Bomb Signal AN–Mk 4 and Mods

The AN–Mk 4 and Mods is designed to be used in all miniature practice bombs. Its purpose is to indicate the point of impact of the bomb by the creation of a flash and a puff of white smoke, allowing an immediate estimate of accuracy to be made.

The Miniature Practice Bomb Signals AN–Mk 4 Mods 0, 1, and 2 are extra-long 10-gage paper shotgun shells having a diameter of 7/8 inch, a length of 5¾ inches, and weighing

2 ounces. They contain an expelling charge of black powder and are primed with a commercial primer. The pyrotechnic charge is separated from the expelling charge by a paper disk and a wad; the ends of the shells are closed by felt wads secured by crimping the ends of the shells.

The AN–Mk 4 Mod 0 is the standard signal and has been in use for a number of years. Mods 1 and 2 are for limited use and contain inert materials which produce very little flash and a smoke puff markedly inferior to that of the Mod 0 signal. Figure 7–13 shows a Signal AN–Mk 4.

The Signal AN–Mk 4 Mod 3 is similar to the AN–Mk 4 Mod 0 but differs in that the case is extruded aluminum rather than paper, the primer has improved storage characteristics, and a pyrotechnic charge is used which produces the same flash, but a superior smoke puff.

The AN–Mk 4 and Mods does not consistently produce a visible signal on impact with water or soft earth when dropped from altitudes of 10,000 feet or greater because the bomb enters the water or earth so quickly that the visible results of functioning are not apparent.

The signal should be inspected prior to loading to make sure it is in good condition, dry, and not swelled or deformed. The primer must not protrude from the head of the case. Signals not complying with the above should be discarded.

Operation.—Place the signal in position in the bomb. Reject the signal if it does not slide into position by its own weight, without the use of force. Place the firing pin assembly in the nose of the bomb with the firing pin toward the signal; the firing pin assembly should slide into place without being forced. Insert and slightly spread the cotter pin which holds the firing pin assembly in place (except in Miniature Practice Bomb Mk 19 and Mods).

The firing pin of the Mk 19 is held in place by a plain pin instead of a cotter pin. To keep the pin from falling out, either peen a slight amount of the lead alloy body over the ends of the pin, or cover both ends with pieces of adhesive tape about 1½ inches square. Do not bend the pin to keep it in place.

When the bomb strikes the water or earth, the firing pin in the nose is forced against the primer of the signal. The primer ignites the expelling charge which forces the pyrotechnic charge out the opening in the tail of the bomb, and at the same time, ignites it. A reddish flash and a puff of white smoke are produced.

Signals AN–Mk 4 and Mods are packed 50 to a cardboard carton, 25 cartons in a wooden shipping box.

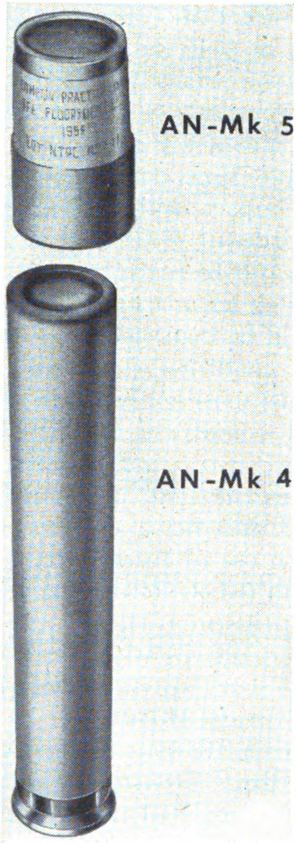


Figure 7–13.—Miniature Practice Bomb Signal AN–Mk 4 and Mods. Miniature Practice Bomb Signal (Fluorescein) AN–Mk 5.

Miniature Practice Bomb Signal (Fluorescein) AN–Mk 5

This signal can be used in any miniature practice bomb in which the Signal AN–Mk 4 and Mods can be used. The AN–Mk 5 is intended for dive bombing practice under certain conditions since, when a wind is blowing, the smoke puff from an AN–Mk 4 signal often blows away before the pilot can get into position to view the results of his attack.

The AN–Mk 5 has a diameter of 7/8 inch, a length of 1¾ inches, and weighs ½ ounce. A shoulder, which increases the diameter of one end, serves to locate the signal in the bomb (fig. 7–13). The signal is composed of a plastic cylinder containing 10 grams of fluorescein dye. This dye is brick red in color but becomes bright green when dissolved in water. The slick, or dye spot, can be seen from an altitude of 15,000 feet. Fluorescein dye is also used in some types of depth charge markers and as life jacket and life raft equipment.

Operation.—The bomb is prepared for use by removing the cotter pin and firing pin assembly. The signal is inserted with the small end of the signal toward the tail of the bomb, only the cotter pin is replaced, and the end is spread. The unused firing pin assemblies should be retained as spares or turned in to the nearest supply point.

Upon impact, water enters the nose of the bomb, breaks the weak ends of the plastic container, and forces the dye out the tail end of the bomb.

These signals are packed 200 to a cardboard carton, 5 cartons in a wooden packing box.

Practice Bomb Signal Mk 6

The Mk 6 is designed for use with 500-pound size and 1,000-pound size practice bombs, and contains about 2 pounds of black powder which serves as a spotting charge. The signal is attached to the tail fin assembly of the bomb with the forward end of the signal seated in an indentation in the after end of the bomb body. The signal is 3 inches in diameter, 11 inches long, and weighs 3¾ pounds. A Mk 247 fuze (fig. 7–14) is used to ignite the black-powder charge.

The forward section of the signal is a sheet steel cylindrical container having a diameter of about 2⅞ inches, a length of 8 inches, and filled with the black-powder charge. When the signal is completely assembled, a chamber in the after end of the powder container holds a caliber .38 blank cartridge, the cartridge being held in place by the Mk 247 fuze. Full instructions for assembling the signal and attaching it to the bomb may be found in Ordnance Pamphlet 998—*Aircraft Pyrotechnics and Accessories.*

The **Fuze Mk 247** is about 4½ inches long and contains a

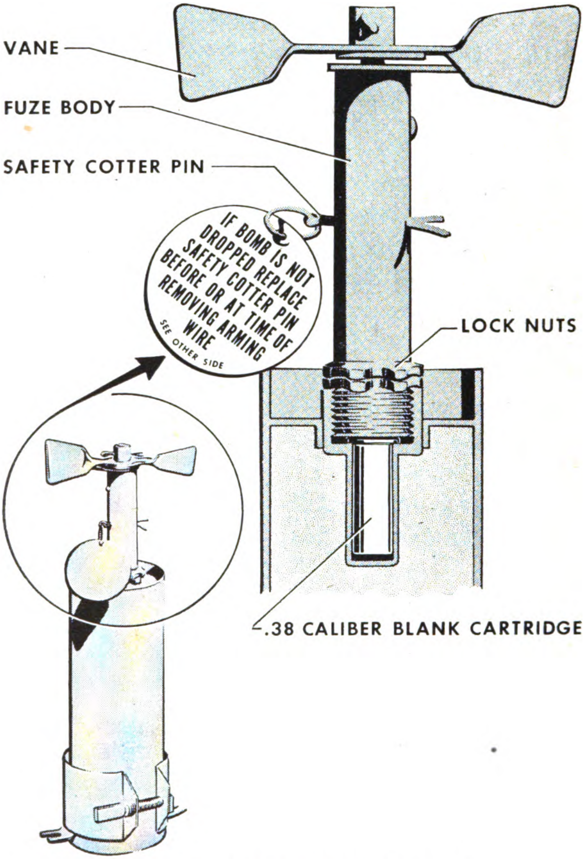

VANE
FUZE BODY
SAFETY COTTER PIN
IF BOMB IS NOT DROPPED REPLACE SAFETY COTTER PIN BEFORE OR AT TIME OF REMOVING ARMING WIRE
SEE OTHER SIDE
LOCK NUTS
.38 CALIBER BLANK CARTRIDGE

Figure 7–14.—Practice Bomb Signal Mk 6.

firing pin armed by rotation of a 2-bladed arming vane. The firing pin is held safe by a threaded shaft secured to the vane; during fall the vane rotates and unscrews the shaft from the firing pin which is then held only by a conical anticreep spring; the vane and shaft fall clear. Upon impact with the ground or water, the inertia of the firing pin carries it forward to strike and ignite the primer of the caliber .38 blank cartridge. Firing of the cartridge in turn ignites the black powder spotting charge, resulting in a flash and a puff of white smoke.

The Fuze Mk 247 is carrier-safe and requires 65 to 240 feet of air travel to arm, when used in the smallest water-sand-filled practice bomb, the 100-pound Mk 15. In larger bombs, a greater amount of air travel is required. A single Fahnestock clip is used on the arming wire of the Mk 247 fuze.

Each Practice Bomb Signal Mk 6 is packed in a corrugated-chipboard box, 8 signals to a wooden shipping box. They must be stowed in a dry, well-ventilated location out of the direct rays of the sun.

Practice Bomb Signal Mk 7

The Signal Mk 7 is designed for use with the 100-pound Practice Bomb Mk 15 Mod 3. The signal contains about one pound of black powder which is ignited by action of a Fuze Mk 247 and a caliber .38 blank cartridge.

The Mk 7 is similar in construction and operation to the Signal Mk 6 but has a body diameter of 2 inches and a length of 14 inches when assembled with fuze. The powder container is about 10 inches long and the fuze end contains the caliber .38 blank cartridge when completely assembled. The signal is attached to the tail fin assembly of the bomb with the signal seated in an opening in the after end of the bomb body.

Full instructions in assembly of the signal and attachment to the bomb may be found in Ordnance Pamphlet 998—*Aircraft Pyrotechnics and Accessories*. Fuze functioning has already been described.

Each Practice Bomb Signal Mk 7 is packed in a corrugated-cardboard carton, assembled with a Fuze Mk 247. The arming vane of the fuze is not attached when shipped but is included in the carton. A cotter pin for securing the vane to the arming shaft, and a caliber .38 blank cartridge are provided in an envelope in the carton. Stowage conditions should be the same as for the Signal Mk 6.

MARKING PYROTECHNICS

Marking pyrotechnics are used over water to provide a stationary reference point on the surface. They are used as aids to navigation by enabling a determination of drift to be made, to mark the point of initial contact with a submarine, to determine wind direction before landing, or to mark the location of the surface for emergency night landing. One type of marker produces a slick on the water while the other type burns, producing smoke and flame.

Marker, Slick, AN–M59

This slick marker is for daytime use only as it does not burn but produces a yellowish green, fluorescent slick on the surface of the water. The slick formed is at least 20 feet in diameter, lasts at least 2 hours, and can be seen at a range of 10 miles from an altitude of 3,000 feet.

The marker consists of a molded plastic case filled with 2.2 pounds of fluorescein dye. The marker is protected by a split cylinder cover of papier-mache (fig. 7–15) which does not interfere with its function.

The papier-mache cover becomes detached from the slick marker during the drop to the water. Upon striking the water, the brittle case shatters completely, scattering the enclosed dye which dissolves to form a slick.

The marker is packed 1 per fiber carton, 10 cartons to a wooden box.

Caution: The plastic case of the Marker AN–M59 is extremely fragile and care must be exercised in handling this item, even when properly packed.

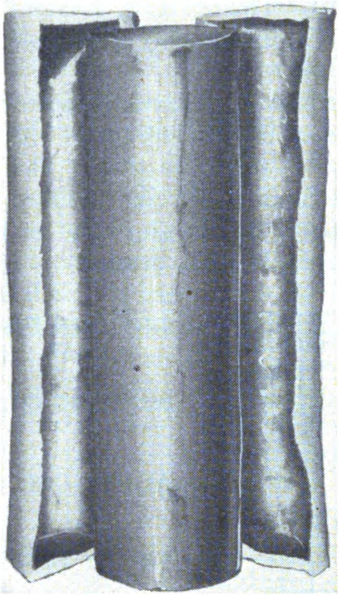


Figure 7–15.—Marker, Slick, AN–M59.

Cartridge, Slick Marker, AN–Mk 1

The Slick Marker Cartridge AN–Mk 1 is designed primarily for antisubmarine warfare use but may be used for any purpose requiring a reference point on the water. The cartridge is composed of a shotgun-type case with primer and black powder propellant charge and containing a dye-filled aluminum container or projectile. The projectile contains 28 grams of fluorescein dye, a black powder bursting charge, and a length of safety fuse. The complete round is 1½ inches in diameter, 3¾ inches long, weighs about 4 ounces and is fired from the Pyrotechnic Pistol AN–M8. By aiming aft, at an angle depending on the ground speed of the aircraft, the slick can be placed at a point vertically below the aircraft at the moment of firing.

When the cartridge is fired, the projectile is propelled from the case, and at the same time, the safety fuse is ignited. The fuse burns 11 seconds and ignites the projectile bursting charge (fig. 7–16). The bursting charge forces the dye out into the water. The dye quickly creates a small bright green slick on the surface.

The projectile has a positive buoyancy so that it will remain on or near the surface until the bursting charge disperses the dye to form the slick. The cartridge should not be fired at altitudes over 500 feet because the projectile will generally burst in the air; this so disperses the dye that a visible slick will not be created.

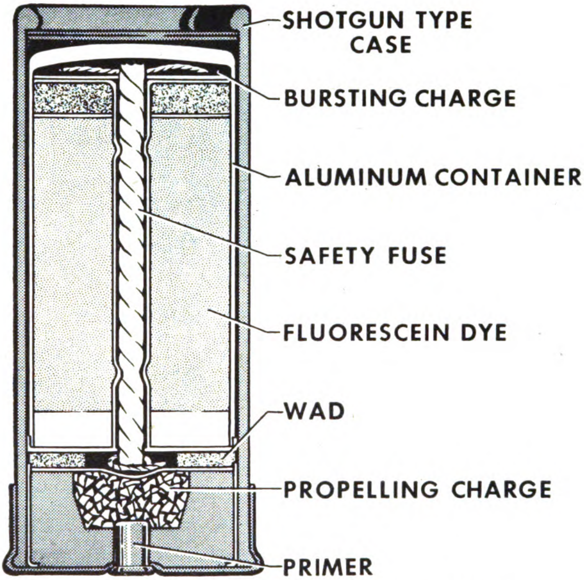


Figure 7–16.—Cartridge, Slick Marker, AN–Mk 1.

Cartridges are packed 10 to a carton, 5 cartons to a container. Five of the containers are packed in a wooden shipping box. They may be stowed with signal cartridges under conditions recommended for stowage of pyrotechnic items.

Signal, Drift, Night, AN–Mk 5 and Mods

Drift signals and float lights float on the surface while burning and give a light and smoke which are visible to an observer in the aircraft from which launched. The AN–Mk 5 and Mods is one of the most commonly used pyrotechnic items in naval aviation; it is used to determine the drift of the plane, to mark the location of an object on the water, or to provide a reference point for any purpose.

The Night Drift Signal AN–Mk 5 and Mods weighs approximately 4 pounds. The body is of wood, 3 inches in diameter and 19 inches in overall length. A flat die-cast nose contains a water-impact fuze at one end, and at the other, a sheet-metal tail fin assembly is mounted (fig. 7–17).

The pyrotechnic mixture is composed of 3 pellets end-to-end, each pellet being 4 inches long and 1¼ inches in diameter, with a 0.22-inch hole through the center, through which passes a length of safety fuse. The pellets are enclosed in a metal pyrotechnic tube to keep the hygroscopic mixture from absorbing moisture through the wooden body. The signal burns from 12 to 15 minutes and the flame can be seen at night for a distance of 6 or 7 miles. The white smoke is readily seen in daylight on clear days, but under hazy conditions, observation is difficult.

The AN–Mk 5 Mod 4 has a sensitized fuze for use in helicopters and lighter-than-air craft; the fuze will function when dropped on the water from an altitude of 50 feet at 0 knots speed, or from any altitude if the release speed is 125 knots or greater. Earlier Mods will function satisfactorily if released at speeds above 100 knots and altitude above 50 feet.

When launched from aircraft, the signal falls nose downward and on impact with the surface, the water breaks the lead sealing disk and drives the firing pin back against the primer. Flame from the primer ignites the safety fuse, which burns about 9 seconds, giving the signal time to return to the surface and right itself.

The safety fuse ignites a length of quickmatch which in turn ignites the first-fire composition. The first-fire composition produces enough heat to ignite the pellet, and gases generated break open the pyrotechnic tube and force out

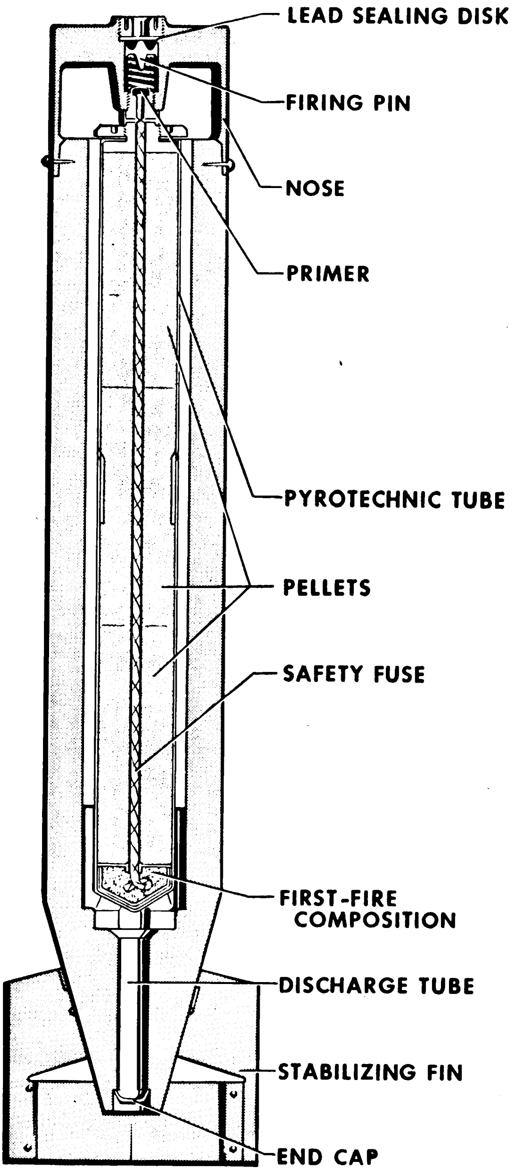


Figure 7–17.—Signal, Drift, Night, AN–Mk 5 and Mods.

the cap which seals the end of the discharge tube. A flame 12 to 15 inches high and a white smoke are produced.

Drift signals are packed in individual corrugated boxes wrapped in a moisture-vapor-proof material, 25 such boxes to a wooden shipping box. They should be stowed in the containers in which they are supplied, in temperatures no greater than 100° F. Aboard ship they should be stowed in pyrotechnic lockers above decks, because burning drift signals produce large quantities of smoke, making fire fighting difficult.

Aircraft Float Light Mk 6 Mod 2

The Aircraft Float Light Mk 6 Mod 2 (and later) provides a long-burning surface marker for day or night use. It consists of a wooden body 5⅛ inches square, 20¼ inches long, and weighs 16 pounds. The body contains 4 Night Drift Signal AN–Mk 5 and Mods pyrotechnic candles, which burn successively for a total of 40 to 60 minutes. A flat die-cast metal nose piece is attached to the forward end of the body, which causes the signal to fall nose down and to remain in an upright position, nose downward, while in the water. No tail stabilizing fins are used.

In the tail end of the body is a pull-type igniter and the outlet holes for the 4 discharge tubes. Each hole is closed with a metal cap and sealed with a square of adhesive tape. This tape MUST NOT be removed prior to launching the float light. A safety fuse provides continuity between the igniter and the top of the first candle, and between the bottom of one candle and the top of the next. Normally there is no delay in transferring the flame from one candle to another but a delay of 90 seconds occurs between actuation of the igniter and ignition of the first candle. This is to give the float light time to return to the surface of the water and become stabilized. The Mk 6 Mod 2 may be launched from aircraft at any altitude up to 5,000 feet.

The pull-type igniter is actuated when the flare is launched by sharply pulling on the ring attached to the friction wire, either by hand or by a lanyard attached to the aircraft structure. THE FLOAT LIGHT MUST BE LAUNCHED IMMEDIATELY AFTER THE IGNITER HAS BEEN ACTUATED. The igniter ignites the safety fuse which runs through the center of the body, and the fuse burns 90 seconds and then ignites the quickmatch and starter mixture at the top of the first candle.

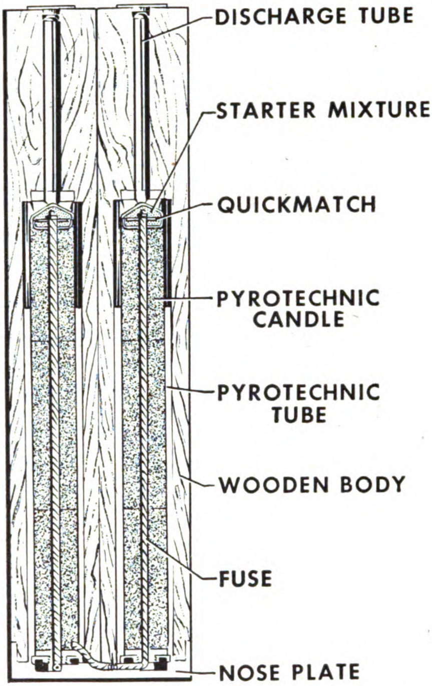


Figure 7–18.—Aircraft Float Light Mk 6 Mod 2.

The gases generated by the burning candle break open the pyrotechnic tube which seals the candle from moisture, force out the end cap, and break the adhesive tape seal, allowing the gases to escape and burn. As each candle burns down to its end, a fuse is ignited which burns to the top of the next candle and ignites it, and this process is repeated until all four candles have burned (fig. 7–18). A flame 10 to 12 inches high and a white smoke are produced.

The Aircraft Float Light Mk 6 Mod 2 is packed individually in moisture-vapor-proof containers, 6 such containers to a wooden shipping box. Aboard ship they should be stowed in pyrotechnic lockers above decks. Stowage temperatures should not exceed 100° F.

Day Depth Charge Marker Mk 1 Mod 3

This marker is used for indicating the initial point of contact with a submarine and provide a reference point for further search and attack during day operations. It may be launched by hand from aircraft or from the decks of surface vessels. After launching, the dye containers in the marker burst, spreading a fluorescein dye on the surface which forms a chrome yellow slick. The slick can be seen for about 3,000 yards from the deck of a ship and about 5 miles from aircraft, and remains on the water for at least 45 minutes—longer under favorable wind and weather conditions.

The Marker Mk 1 Mod 3 has a diameter of 3½ inches, is 11⅞ inches long, and weighs approximately 3½ pounds. It consists of a circular wooden block on which is mounted a grenade firing mechanism similar to that shown in figure 7–10, except that the release lever is curved. Fluorescein dye is contained in 2 cylindrical kraft paper containers, 1 attached to each flat side of the wooden block (fig. 7–19). A plastic tube containing a bursting charge of black powder extends through the wooden block into both dye containers, and a length of safety fuse connects the primer of the firing mechanism and the bursting charge.

Earlier Mods of this marker produce a green dye which often causes confusion with dye slicks marking downed aircraft. To prevent this, the Mk 1 Mod 3, which produces a CHROME YELLOW slick, has been adopted as the service day depth charge marker. Earlier Mods if still on hand, should be used for training purposes only.

To prepare the marker for launching from aircraft at altitudes up to 1,000 feet, grasp the marker firmly in one hand, being sure the release lever is held firmly against the body of the marker. With the other hand, pull the safety ring which is attached to the safety pin. After removal of the cotter pin, launch the marker by throwing it over the side.

The operation of the grenade firing mechanism has already been described; it ignites a length of safety fuse which burns about 15 seconds and then ignites the bursting charge. The expanding gases produced by the burning bursting charge break open the dye containers and spread the dye on the water.

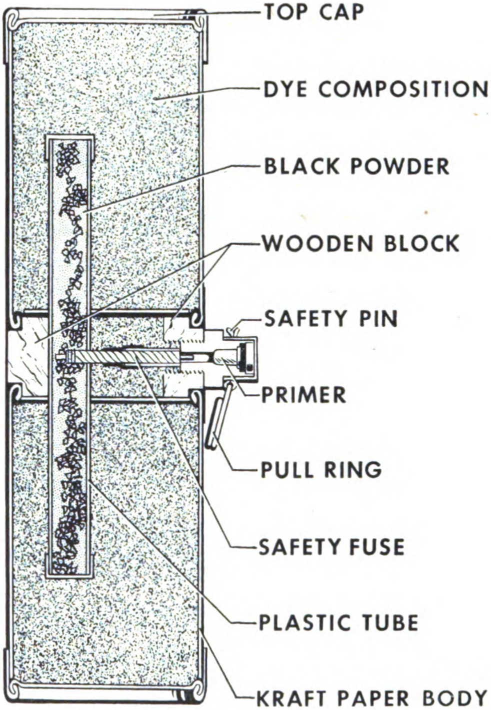


Figure 7–19.—Day Depth Charge Marker Mk 1 and Mods.

Caution: After removing the safety cotter pin, it is EXTREMELY IMPORTANT to hold the release lever firmly against the body of the marker until launching. Only a small movement of the release lever is required to free the striker. NEVER REMOVE THE FIRING MECHANISM FROM THE MARKER UNDER ANY CIRCUMSTANCES.

Markers Mk 1 and Mods may be launched from aircraft at ANY altitude, provided the safety cotter pin is not removed. Impact with the surface will crush the dye containers, releasing the dye to produce a slick slightly smaller than that produced otherwise. In general, the firing mechanism should be actuated for release at altitudes under 1,000 feet, and left unfired for releases at altitudes over 1,000 feet. If the firing mechanism is actuated for releases at altitudes over 1,000 feet, the marker will burst in the air, scattering the dye to such an extent that a visible slick will not be produced.

The Day Depth Charge Marker Mk 1 Mod 1 is packed individually in an asphalt-impregnated container which is sealed with adhesive tape, 10 such containers to a wooden shipping box. The Marker Mk 1 Mod 2 is packed individually in a moisture-vapor-proof bag and then in a carton. Ten of these cartons are packed in a wooden shipping box.

Markers Mk 1 and Mods should be stowed in a dry, well-ventilated place. The temperature in the magazine or locker should not be allowed to exceed 100° F.

Night Depth Charge Marker Mk 2

The Night Depth Charge Marker Mk 2 is used for indicating the initial point of contact with submarines and to provide a reference point for further search and attack during night operations. It may be launched by hand from aircraft at altitudes up to 3,000 feet, and under average atmospheric conditions, can be seen from the deck of a ship at distances up to 4 miles and from aircraft at distances up to 10 miles.

The marker is a sealed cylindrical metal can 5 inches in diameter, 7 inches long, and weighing about 2½ pounds. A centrally-located tube within the can contains a small charge of calcium phosphide, and the main charge of calcium carbide surrounds this tube. On each end of the can is a tear strip with pull ring attached which seals two small holes to permit entrance of water when the marker is thrown overboard. A cutaway view of the marker is shown in figure 7–20.

Before launching, the two tear strips MUST be pulled off

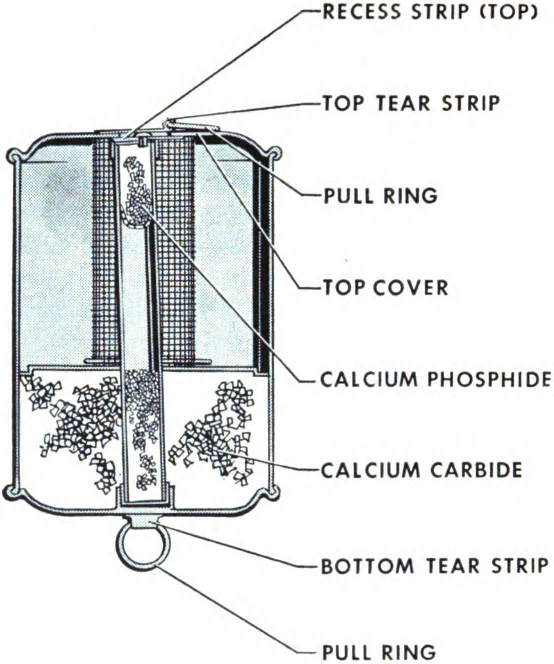


Figure 7–20.—Night Depth Charge Marker Mk 2.

the ends of the container. The marker is then launched by throwing it over the side. Water enters the container through the holes in the ends and reacts with both the calcium carbide and the calcium phosphide. Water and calcium carbide combine to produce acetylene, an inflammable gas, while water and calcium phosphide combine to produce phosphine, a spontaneously-ignited gas. In operation, the gases produced escape through the holes and ignite within 70 to 90 seconds after impact with the water. The phosphine gas ignites spontaneously and in so doing ignites the acetylene, producing a flame about 9 inches high which burns without smoke for a period of at least 45 minutes. If the flame is put out by rough seas, the gases will ignite again.

Caution: These markers should be stowed separately from other pyrotechnics if possible. Do not stow in a compartment equipped with sprinklers, or fight fires near Markers

Mk 2 with water, since the markers will ignite when water strikes their contents. Do not handle or hold by the tear strip pull ring; the tear strips must not be removed until just prior to use. Markers should be inspected periodically to insure that tear strips are in place and the seams are tight; if the watertight integrity is broken the markers may evolve acetylene and phosphine gradually. These gases may collect in enclosed places to produce hazardous concentrations that can explode if ignited.

Night Depth Charge Markers Mk 2 are packed 12 to a corrugated cardboard container.

SAFETY PRECAUTIONS FOR PYROTECHNICS

Pyrotechnic ammunition is one of the most widely used types of munitions in naval aviation; pyrotechnics of one type or another are carried in almost every Navy aircraft, including unarmed transport and training planes. Consequently, the Aviation Ordnanceman handles a great deal of it, especially while serving in the fleet, and the tendency to become careless through long familiarity with pyrotechnics handling often becomes pronounced to a dangerous degree.

Pyrotechnics contain material of an extremely dangerous nature. Special precautions for certain pyrotechnics are prescribed in the section relating to the specific item. The following general precautions should be observed at all times:

Pyrotechnics should be handled carefully. Rough handling may cause immediate functioning, or may damage the item so it will not function properly at the time desired. Some pyrotechnic ammunition is MORE DANGEROUS than other types of service ammunition, and its proper functioning is EQUALLY IMPORTANT.

Whenever possible, pyrotechnics should be stowed in the boxes or water tight containers in which they are supplied, and should be separated according to type, color, and lot number.

Functioning of pyrotechnics is affected by moisture, so they should be stowed in a dry, well-ventilated place. Most pyrotechnics are packed in moisture-proof containers; the seal of such packings should not be broken until just before the item is to be used. Pyrotechnics exposed to moisture should be segregated until an examination has proved they are safe and serviceable.

Pyrotechnics should not be stowed where the direct rays of the sun can strike them, and they should be protected from excessive and variable temperatures. The temperature in stowage spaces should be below 100° F. The main reason for this temperature limitation is that many pyrotechnic items incorporate commercial percussion-type primers containing fulminate of mercury which deteriorates rapidly at temperatures exceeding 100° F.

Aboard ship, smoke-producing pyrotechnics should be stowed above deck if possible, because it is difficult to combat fire in these materials when they are stowed where the smoke produced is not blown away. Water-activated items should be stowed separately. If water is used to fight a fire, the water may spread the fire by activating the pyrotechnics.

Smoking or carrying lighted cigarettes, cigars, or pipes is not permitted in the vicinity of pyrotechnics. Matches and other flame or spark-producing articles should not be carried near places where pyrotechnics are stowed.

When a cartridge-type pyrotechnic misfires, make at least two more attempts to fire it. If it still fails to fire, the pistol or projector may be unloaded after waiting a minimum of 30 seconds. Because of the possibility of a hangfire, this rule should NEVER be disregarded.

Because of the nature of pyrotechnics, most types deteriorate in a shorter period of time than other types of service ammunition. The oldest serviceable pyrotechnics available should be issued first to insure the continuing availability of a fresh stock.

Pyrotechnic ammunition aboard aircraft must be stowed securely. For example, a loose flare may ignite and cause a serious accident if the ripcord or arming plate fouls on other gear or on some projection.

Flares are more dangerous as a fire hazard than many types of ammunition because they are so easily activated and because of the great heat developed by the burning illuminant candle. Extreme care is necessary in stowage, use, and handling. Flares exposed to excessive moisture or mechanically damaged by rough handling shall be returned to ammunition depots, dumped overboard, or burned. Flares should never be disassembled and parachutes or other components removed, nor should they be left in aircraft indefinitely grounded.

When directed by the Bureau of Ordnance, defective and obsolete items of pyrotechnics may be disposed of by either dumping overboard or burning. Dumping must be done at least 10 miles offshore and in water more than 500 fathoms deep. Dumping is preferred to burning because it involves less preparation and hazard. Full instructions for dumping or burning pyrotechnics may be found in OP 998—*Aircraft Pyrotechnics and Accessories* (Second Rev.). Specific BuOrd instructions cover the disposition of photoflash bombs and certain other items not mentioned in OP 998.

Photoflash Bombs AN–M146 are EXTREMELY DANGEROUS and must be handled with great care. They detonate with a high-order explosion. Duds should be handled with extreme caution, particularly if they have distorted or ruptured cases. The slightest friction may set off the loose photoflash powder with which these bombs are loaded, and unfuzing duds of this class of bombs DOES NOT render them safe to handle.

If possible, such duds should be destroyed in place, using two ½-pound blocks of TNT. Such work should be undertaken only by qualified explosive ordnance disposal personnel. Removal of duds is extremely hazardous and should be done only in emergencies.

SMOKE SCREEN EQUIPMENT

Aircraft chemical spraying is defined as the spraying or dispersing of liquid chemical agents in droplets or in atomized form from tanks carried on an airplane. Thus "spraying" includes "smoking." Naval cognizance of the mechanical equipment, such as aircraft smoke tanks, is under the Bureau of Aeronautics, while the Bureau of Ordnance has cognizance over the smoke and toxic agents used with the spray equipment.

Aircraft chemical spray may be used for:

1. Producing casualties (war gases).
2. Harassing the enemy (war gases).
3. Denying areas to the enemy (persistent vesicant spray, such as mustard gas).
4. Reducing visibility (smoke screens).

War gases have not been used in hostilities since World War I of 1914–1918, although both sides in World War II maintained large stocks of this type weapon. Barring its use in any future war, the Aviation Ordnanceman will be concerned with aircraft chemical tanks only for smoke screen-laying purposes; however, it should be borne in mind that these tanks function equally well with either smoke or vesicant spray, the two main types of chemical agents used in aerial spraying.

Persistent Vesicants

VESICANTS are chemical agents which produce a blistering effect upon the skin. Persistent vesicants sprayed on an area will contaminate the area for a period ranging from about two days to several weeks, the time depending upon weather conditions. The vesicants most likely to be used are MUSTARD (H) and LEWISITE (L), or chemical agents similar to these war gases. While these vesicants are called "poisonous gases," actually they are oily liquids which vaporize slowly and have a high boiling point.

Mustard and lewisite are readily absorbed by rubber, leather, wood, and other porous articles, and in a short time will penetrate rubber boots, gloves, or other articles of clothing, if these are bought into contact with the liquid. Therefore most articles of clothing which have not been specially treated will not provide protection against liquid or vaporous mustard and lewisite.

Chemical freezing deterrents and stabilizers may be mixed with mustard. A thickening agent is desirable and is mixed with mustard for other than low-altitude spraying in order to increase the size of the drops and therefore the rate of fall, thus making higher-altitude spraying more economical, accurate, and practicable.

Mustard or lewisite have distinctive odors in low concentrations and are decidedly pungent in high concentrations and consequently their presence can usually be detected by smell alone. However, in recent years some very potent chemical agents have been developed which have very little odor, even in high concentrations, and these new agents have been termed "NITROGEN MUSTARDS." The nitrogen mustards are not as persistent as mustard, but because of their comparative lack of odor, are difficult to detect. The greatest danger from this gas is in the fact that the eyes and lungs may be damaged before the presence of gas is suspected if reliance is placed on smell alone. The gas acts as a vesicant or irritant to all exposed tissues, including the eyes, skin, respiratory tract, and stomach.

The nitrogen mustards may be sprayed in the same manner as mustard or lewisite.

Smoke Mixtures

A smoke is a cloud of minute particles of solids, liquids, or both, which are suspended in the air. These particles may vary in size from those large enough to be seen by the naked eye to those almost as small as a single molecule. Most of the effect of a screening smoke comes from the reflection and refraction by the many smoke particles, rather than from the actual obstruction of the light rays. A white smoke is a more effective screening agent than a black smoke because of the superior refraction and reflection qualities of white smoke. It is obvious that the smaller the particles of smoke are, the more effective the screen will be, since more smoke particles will be produced by a given quantity of smoke material and more reflection will be the result.

The two smoke mixtures most commonly used by the Navy in laying smoke screens from aircraft are FS (sulfur trioxide in chlorsulfonic acid) and FM (titanium tetrachloride). These materials are liquid at ordinary temperatures and when sprayed from aircraft they mix with the moisture in the air to form white smoke. Since they depend to a large extent upon the moisture in the air for their greatest effect, a high moisture content is required to produce a good smoke screen with a minimum amount of liquid smoke material. As the humidity decreases, an increased amount of smoke material is required to produce a good screen. Temperatures considerably below freezing are not favorable for laying screens with these chemicals as the actual moisture content of the air is low.

FS consists of approximately 55 percent sulfur trioxide and 45 percent chlorsulfonic acid by weight. The purpose of the chlorsulfonic acid is to keep the sulfur trioxide in a liquid state at the lowest temperatures likely to be encountered; with the 55–45 mixture the sulfur trioxide remains liquid down to temperature below minus 22° F. The chlorsulfonic acid has fair smoke-producing qualities but the sulfur trioxide is the chief smoke producer. On contact with the moisture in the air, the sulfur trioxide forms sulfuric acid, while the chlorsulfonic acid forms sulfuric and hydrochloric acid. The smoke produced causes irritation of the skin and throat, but is harmless since the concentration of acid in a smoke is very low.

Liquid FS, which practically always has some water present, has very strong corrosive properties. It has a very slight reaction with monel, as compared with other metals. However, water-free FS is relatively noncorrosive and is usually shipped satisfactorily in tightly sealed steel containers. FS weighs 15.8 pounds per gallon.

FM is a colorless liquid which in contact with the moisture in the air produces a smoke composed of titanium hydroxide and hydrochloric acid. The titanium hydroxide is water-absorbing and the smoke soon becomes composed of combined solid and liquid particles. The hydrochloric acid, being hygroscopic, also helps form the smoke. FM smoke is harmless and only slightly irritating.

Moisture should not be allowed to come in contact with FM smoke mixture as traces of moisture cause the formation of solid titanium hydroxide, which tends to settle and might cause trouble on discharge. FM produces a good smoke when the humidity is average and is considered better than FS in cold weather, but the smoke tends to dissipate rapidly. With a higher humidity, the smoke dissipates more slowly. FM is corrosive, but not nearly so much as FS smoke mixture. FM weighs 14.5 pounds per gallon.

Chemical Filling Equipment Mk 1 Type

Chemical agents and smoke mixtures are generally shipped in 55-gallon metal shipping drums. Chemical Filling Equipment Mk 1 Mod 7 is provided for transferring the liquid agent from the drum to the two types of chemical tanks used by the Navy, the Mk 10 and the AN–M33A1. This equipment consists of a 1-inch diameter flexible metal filling hose, a 3/8-inch diameter flexible metal vent hose, a special drainage elbow, and the necessary valves, gaskets, and adapters to fill the tanks.

Using this special filling equipment permits transferring the liquid chemical agent from the 55-gallon shipping drum to the tank with a minimum exposure of the liquid to the atmosphere. The liquid entering the tank displaces the air and vapors in the tank; these vapors are then vented back into the shipping drum through the vent hose, thus giving a closed filling system.

In addition to the special filling equipment, it is necessary to use a scale capable of weighing up to 1,000 pounds or more. The best way of filling the tanks is to calculate the weight of the number of gallons of mixture desired, add the weight of the empty tank, and let the mixture flow into the tank until the scale indicates the predetermined weight. A supporting stand or bomb skid for holding the tank on the scale and a hoist with the necessary accessories for raising the shipping drum above the tank are also required.

Full instructions for the use of Chemical Filling Equipment Mk 1 Type in filling tanks with either vesicant war gases or smoke mixtures may be found in NavAer Manual titled "Chemical Spraying Equipment".

Aircraft Chemical Tanks

The original design of the two aircraft chemical tanks currently used by the Navy was developed by the Army Chemical Corps. The Army models were adapted for Navy use by means of various modifications and these Navy-modified versions are now standard equipment for naval activities.

Both tanks are the gravity flow type and employ breakable glass closure disks in the air inlet and discharge lines. The lines are opened simultaneously by blowing out the glass disks with electric blasting caps which are connected by means of an electrical connector to the aircraft's electrical circuit.

When spraying FS smoke mixture, best results will be had by installing a discharge tube restrictor plate just ahead of the glass closure disk in the discharge tube of either tank. Without the restrictor plates, an excessive amount of FS is discharged and the resulting over-dense screen has a tendency to rise.

No restrictor plate is required for spraying vesicant gases, both tanks having discharge tubes designed for maximum effectiveness as issued.

The tanks are hoisted to and suspended from bomb racks and shackles in the same manner as bombs, mines, or other military stores. When installed in bomb bays, special discharge tubes are used which extend beyond the bomb bay doors. Before the tank is hoisted to the rack or shackle, a "no-voltage" test must be made of the firing circuit; the electric detonators are very sensitive and can be exploded at a current of ½ ampere and ½ volt. The last operation before the plane takes off is the installation of the detonators in the air inlet assembly and discharge tube. Either tank can be jettisoned if necessary. Detailed instructions in the filling and preparation for use of both tanks, as well as other pertinent instructions, may be found in NavAer Manual titled "Chemical Spraying Equipment." A general description of Navy aircraft chemical tanks follows.

Aircraft Chemical Tank Mk 10

The Mk 10 is a modified version of the Army Tank M10 and will successfully withstand long-term storage, salt spray, catapulting, and arrested landing. It is the only Navy tank which can be used on carrier aircraft.

The Mk 10 is streamlined in shape (fig. 7–21), weighs 68 pounds empty and has a capacity of 33 gallons. To allow room for the expansion of the liquid filler, the tank is filled with only 32 gallons of chemical agent. The total weight of the filled tank depends upon the chemical agent used.

The tank is 14 inches in diameter and 68 inches long; when assembled with its discharge tube the overall length is 84 inches. Two suspension lugs, spaced 14 inches apart, are provided for suspension from double-hook racks and shackles, and a single folding type lug assembly provides for single-hook suspension. The forward pin of this folding-lug assembly is used for hoisting. The tank is reinforced at each lug position. An insulating cover for the tank is available for use in freezing weather or high-altitude flying.

The air inlet assembly is screwed into the upper forward end of the tank and consists of an elbow housing the glass closure plate, and a funnel through which air enters the inlet when the closure plate is broken. The funnel contains the detonator retaining screw which holds the detonator in place against the closure plate. The detonator is a commercial No. 6 blasting cap. The closure plate for the air inlet is a disk of $\frac{3}{16}$-inch thick flat tempered glass. (See fig. 7–21.) The tank is filled through the opening for the air inlet assembly.

The discharge tube is screwed into the lower rear of the tank proper. It contains the glass discharge tube closure plate, a detonator, and two plastic gaskets which are completely resistant to all chemical agents used in this tank and which provide a tight seal around the closure plate. The detonator is a commercial No. 6 blasting cap, while the

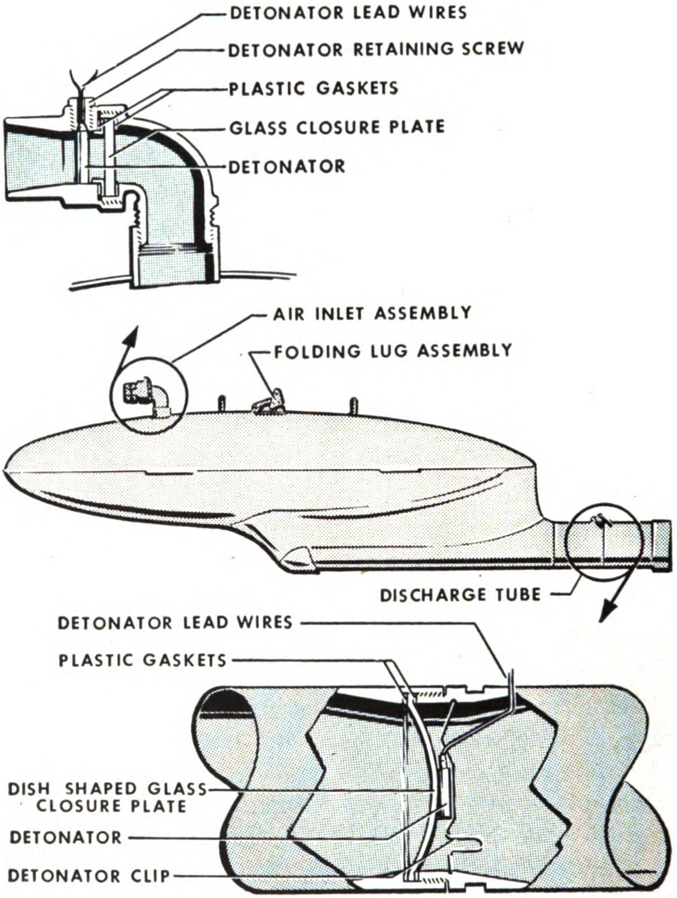


Figure 7–21.—Aircraft Chemical Tank Mk 10.

closure plate is a dish-shaped disk of Pyrex glass and is extremely strong. When the discharge closure plate is installed, the bulge in the glass (that is, the convex side) MUST FACE OUTWARD TOWARD THE OPEN AIR.

During storage of a filled tank, both the air inlet and discharge tube openings are closed with a metal cover to protect the glass closure plates from breakage. Filled tanks may be safely stored for at least six months, although care is required in handling due to the tank's thin shell.

In spraying, the contents of the tank are released by passing a current of electricity from the aircraft circuit through the air inlet and discharge tube detonators, which are connected in series. Closing the circuit explodes the detonators and breaks the glass closure plates, thus releasing the chemical agent. The current of air entering through the inlet helps force the liquid agent out through the discharge tube. Without a restrictor plate installed, the tank will completely discharge in about 6 seconds.

The gray-painted tank is shipped one to a wooden crate, and together with a separate box containing component items and except for detonators, is complete for one mission. Extra gaskets and closure plates for additional missions may be ordered separately. After use, the tank must be cleaned or decontaminated immediately and if the empty tank is to be stored for any length of time, the inside of the tank should be coated with oil. However, this oil coating must be thoroughly wiped off prior to refilling.

Airplane Smoke Tank AN–M33A1

This is a standardized version of the Army M33 tank. The AN–M33A1 has two sets of beads (fig. 7–22) to permit positioning of the suspension bands for either 30-inch or 14-inch suspension. The tank proper is cylindrical with ogival ends, with a diameter of 21¼ inches and an overall length (without discharge tube) of 64¾ inches. The complete tank when empty weighs approximately 175 pounds; full weight depends upon the liquid agent used, although the maximum weight, regardless of filler, is about 1,340 pounds. This includes the insulating jacket used for high-altitude or cold-weather spraying.

The tank holds 78 gallons, but fillable capacity is 70 gallons, to allow an 8-gallon or 10-percent void for expansion of the chemical agent. Two types of discharge tubes are available to permit use of the tank on a number of different model aircraft. Unlike the Mk 10 tank, the AN–M33A1 is filled through either of two 1½-inch filling openings at the upper rear of the tank. These openings are closed by pipe plugs. Two baffles inside the tank reduce the sloshing or surging of the liquid filler and at the same time strengthen the tank structure.

The air inlet assembly is contained in the discharge tube (fig. 7–22) and consists of a tube, a No. 6 electric blasting cap and a detonator clip, and the flat glass closure plate with its gaskets. An air inlet ice shield is available for use under conditions where ice might form on the discharge tube and block the air inlet. The ice shield is a light-gage sheet metal cover which overlaps the air inlet opening and is held in place by two spring clips which also hold the detonator. When the ice shield is used, its detonator is connected in series with those for the two glass closure plates, and all three detonate simultaneously.

The discharge line M1 is shown in figure 7–22. It contains a detonator (a No. 6 electric blasting cap) which is mounted adjacent to the dish-shaped Pyrex glass closure plate. The closure plate is sealed with two gaskets.

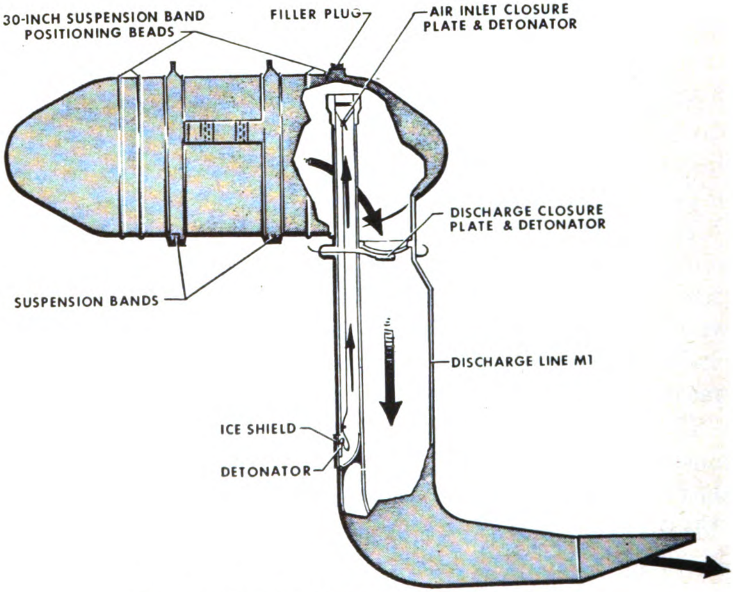

30-INCH SUSPENSION BAND POSITIONING BEADS
FILLER PLUG
AIR INLET CLOSURE PLATE & DETONATOR
DISCHARGE CLOSURE PLATE & DETONATOR
SUSPENSION BANDS
DISCHARGE LINE M1
ICE SHIELD
DETONATOR

Figure 7–22.—Airplane Smoke Tank AN–M33A1.

The operation of the tank is similar to the Mk 10 previously described. Air inlet and discharge tube closure plates (as well as the ice shield, if used) are blown out by the detonators. Air entering the air inlet opening vents the tank and helps force the liquid agent out the discharge tube, although the flow is principally due to gravity. The flow rate is approximately 10 gallons per second without a restrictor plate; thus the tank will empty in about 7 seconds.

STORAGE AND SAFETY PRECAUTIONS

Liquid chemical agents should be stored in a cool, dry, fireproof storage place which has sufficient ventilation to vent any vapors which might collect from a leaking container. The deck or floor of the storage place should be made of steel or a specially treated, nonabsorbent concrete. Wood or any rubberized materials should never be used for flooring.

Chemical tanks or other containers filled with a liquid chemical agent should be placed on racks or stands constructed so that each container, or stand and container together, can be readily removed in case of leakage, fire, or other emergency.

Each storage place or magazine should have a set of first aid and decontaminating instructions and gas warning signs posted in a conspicuous place. First aid and decontaminating materials should be kept on hand whenever handling chemical agents; detailed procedures for using these materials may be found in pertinent NavAer instructions.

Aboard ship, storage space for filled chemical tanks should be located so that leakage would not allow vapors to spread through the interior of the vessel. Mechanical ventilation of the storage space should exhaust possible fumes directly to the weather. If the space involved is topside aft, a rapid and safe means of jettisoning the tanks or containers should be available.

The temperature of the storage place should be kept below 110° F. since the stability of chemical agents is decreased at higher temperatures. The loaded tanks should never be stored in the direct rays of the sun or near artificial heat, except during cold weather, when the object is to keep the chemical agent from freezing before use.

LIQUID CHEMICAL AGENTS SHOULD NOT BE STORED WITH ANY TYPE OF AMMUNITION. If possible, different types of chemical agents should be stored separately. Vesicants are not inflammable and are only slightly corrosive; their chief danger is to personnel because of their extremely toxic nature. Smoke mixtures are extremely corrosive to most metals and attack almost all materials, but are not inflammable. However, should containers burst in a burning building or space, great quantities of smoke will be produced, making fire fighting difficult.

Aboard ship, containers of chemical agents should be inspected daily. Ashore, a weekly inspection is sufficient.

Only trained, experienced personnel should fill aircraft chemical tanks and a competent officer should be in charge of the operation. Filling must be done downwind from personnel and equipment so that toxic fumes will not be blown toward them. Those doing the filling should wear the appropriate protective clothing and gas masks, and care must be taken that any spilled chemical agent is immediately decontaminated. Extreme care must be taken in dismantling the filling equipment after use, prior to decontaminating it. Great caution must be observed in removing the plug from the shipping drum prior to filling, as pressure sometimes develops within the drum.

Before filling, tanks must be carefully inspected to be sure they are clean and dry and that they are undamaged. Water in vesicants forms corrosive acid and generates gas pressure. Any worn or defective parts should be replaced, especially defective gaskets; a suitable grease, such as soft graphite grease, is recommended for use on gaskets and threads of equipment ONLY WHEN USED WITH VESICANTS.

On the other hand, FS and FM react with explosive violence when they come in contact with water or grease. If grease has been applied to gaskets and threads, the greased surface must be cleaned sufficiently by wiping all exposed surfaces with a clean rag or piece of waste.

Detonators should not be installed in chemical tanks until just prior to takeoff. A no-voltage test of the firing circuit should be made before connecting the detonator pigtail. All personnel except the man concerned should stand clear of the tank while the detonators are being installed and connected.

These instructions and safety precautions, like others in the text, are of necessity only general in scope. Chemical agents are extremely hazardous to handle and the careless or ill-informed man can endanger the lives of may others. Before handling these agents (particularly war gases, should the necessity ever arise), the Aviation Ordnanceman is strongly advised to thoroughly study NavAer instructions and other publications dealing with the subject.

QUIZ

1. The three purposes served by aircraft pyrotechnics are __________, __________, and __________.
2. The Aircraft Parachute Flare Mk 6 and Mods has a light intensity of ______ candlepower.
3. The Aircraft Parachute Flares AN–Mk 8 and Mods are designed primarily for ______ ______ operations.
4. The Photoflash Bomb AN–M46 is used to illuminate an area for __________ __________.
5. In aircraft, signal cartridges are fired from a __________.
6. Distress signals for daytime use produce (1) __________ while those for night use produce a (2) __________.
7. Slick markers generally contain __________ dye to produce a green slick on the surface of the water.
8. Because of the possibility of a hangfire, a signal cartridge should not be removed from the pistol or projector for at least __________ after the last attempt to fire it.
9. TRUE OR FALSE: A dud Photoflash Bomb AN–M46 should be unfuzed and the bomb disassembled immediately upon discovery.
10. The two aircraft chemical tanks used by the Navy are the __________ and the __________.
11. To fill these tanks, Chemical Filling Equipment Mk ____ Mod ____ is used.
12. The two smoke mixtures used by the Navy are __________ and __________.

CHAPTER 8

MUNITIONS HANDLING EQUIPMENT

INTRODUCTION

Handling munitions is a difficult task for all personnel concerned. Moreover, the nature of the material demands that prescribed safety precautions be rigidly observed at all times regardless of the familiarity and monotony of the work. To ease the burden and reduce the danger of the munitions handler's task, many items of special equipment have been designed. These items are grouped under the general term, MUNITIONS HANDLING EQUIPMENT.

The handling of aircraft munitions from its arrival, into stowage, and through the assembly and stowage areas, varies little whether afloat or ashore. The mechanical equipment used to handle aircraft munitions afloat and ashore is often identical. On the other hand, differences in stowage accommodations, fixed installations, working areas, and space allowances sometimes require munitions handling equipment and techniques specially designed for the job. The number of such items is extremely large; however, the equipment covered in this chapter meets the primary requirements of most operating units, ashore or afloat.

BOMB CARRIERS

Bomb carriers provide a quick and safe means of attaching a crane cable or other hoisting device to a bomb for conveyance from one area to another. Bomb carriers have been designed for carrying crated bombs as well as uncrated bombs. Some carriers are designed for horizontal lifting (lifting the bomb in a horizontal position), while others may be used for both horizontal lifting and vertical lifting. Carriers of the latter type are equipped with two lifting lugs.

The capacity of each carrier is plainly marked thereon and ranges from 1,000 pounds to 4,000 pounds. You should never exceed the given capacity of any bomb carrier, and always be careful to select the proper carrier for the job.

Bomb Carrier Mk 3 Mod 1

The Bomb Carrier Mk 3 Mod 1 is used to lift and carry crated bombs weighing up to 1,000 pounds. It has a center lifting eye bolted between a pair of side plates separated by spacers. Double-pronged carrying hooks are hinged to the ends of the plates. These hooks catch the end rims of the crated bombs and may be adjusted for bombs of various lengths. Slings may be attached to the hooks for suspending uncrated bombs.

Bomb Carrier Mk 4

The Bomb Carrier Mk 4 is used to lift and carry uncrated bombs weighing up to 2,000 pounds. The center lifting eye is bolted between a pair of side plates, having a rigid hook at each end. These hooks, spaced 14 inches center to center,

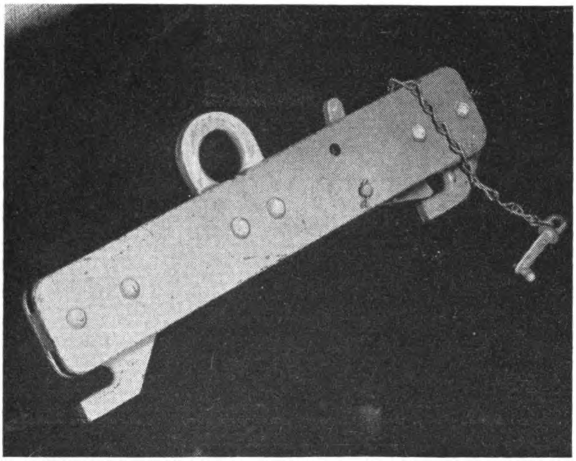


Figure 8–1.—Bomb Carrier Mk 4.

slide into the suspension lugs of the bomb. A spring-loaded latch prevents one hook from slipping out of the bomb lug, and holds the bomb in place until pressure on the upper extension releases the latch. A pin is also provided to prevent the latch from being accidentally opened.

Bomb Carrier Mk 6

The Bomb Carrier Mk 6 is a beam used to lift and carry bombs that have suspension lugs spaced 14 inches center to center. The capacity of the carrier is 1,600 pounds. One end of the beam is bent at a 30° angle to conform to the shape of the nose end of the bombs.

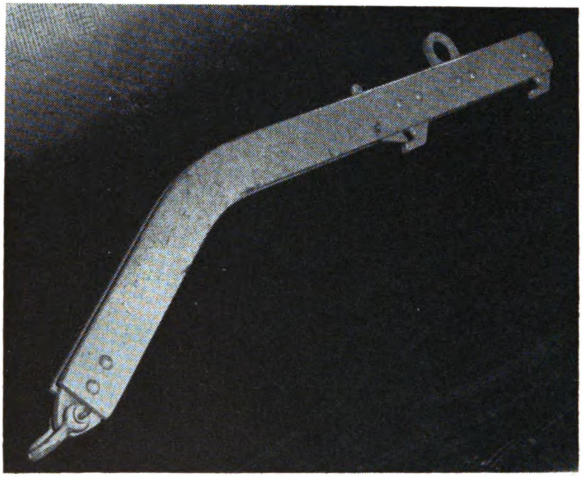


Figure 8–2.—Bomb Carrier Mk 6.

Riveted between the side plates of the carrier are two carrying hooks, 14 inches apart, and two lifting eyes. The center lifting eye is halfway between the carrying hooks and is used for horizontal lifting. The second lifting eye is at the bent end of the shackle and is used for vertical lifting.

The Mk 6, like the Mk 4, is equipped with a spring-loaded latch and safety pin.

Bomb Carrier Mk 7 and Mk 8

The Bomb Carrier Mk 7 is used to lift and carry bombs that have suspension lugs spaced 30 inches center to center. The capacity of the carrier is 4,000 pounds. Two rigid carrying hooks are riveted 30 inches apart between two channels placed back to back. The center lifting lug, for horizontal lifting, is riveted midway between the hooks. For vertical carrying, the shackle end of the carrier is bent 30° to conform to the shape of the nose end of the bombs to be carried. A spring-retained latch is also provided.

The Bomb Carrier Mk 8 is identical to the Mk 7 except that the Mk 8 is not equipped for vertical carrying. Both carriers are provided with a spring-loaded latch and safety pin.

Bomb Carrier Mk 9

The Bomb Carrier Mk 9 is used to lift and carry uncrated bombs equipped with suspension lugs spaced 14 inches between centers. It has a capacity of 1,600 pounds. The Mk 9 is similar to the Mk 4 but is arched in the center. This provides clearance in the middle of the beam for installing a trunnion band while the carrier is in place on the bomb. A spring-retained latch and safety pin are provided as on other rigid hook carriers.

BOMB AND TORPEDO SKIDS

Bomb and torpedo skids are used in transporting all types

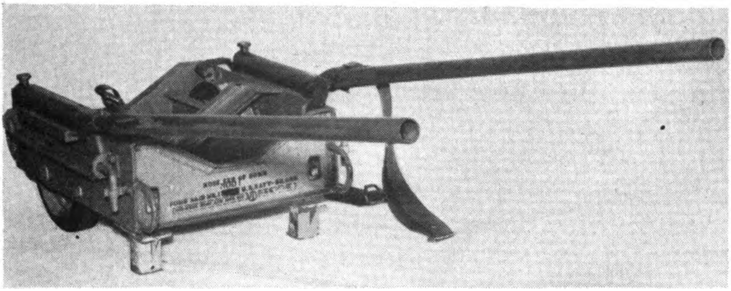


Figure 8–3.—Bomb Skid Mk 1 Mod 1.

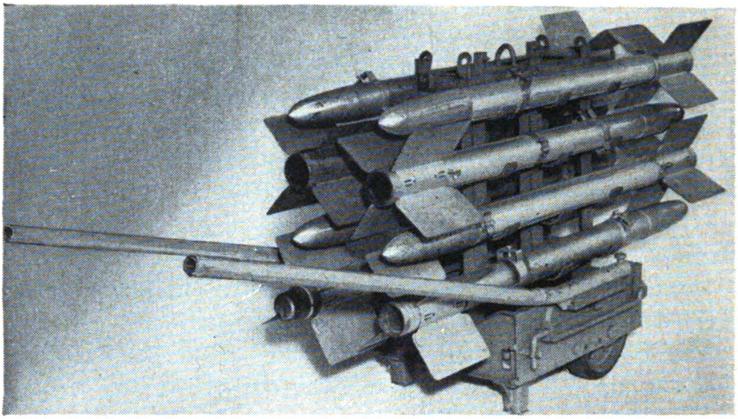


Figure 8–4.—Bomb Skid Mk 1 Mod 1 fitted with Adapter Mk 3.

of munitions from the magazines to the aircraft. Although most skids are designed for carrying a single bomb or torpedo, adapters which may be fitted to the skid make possible the transporting of almost any type of load. Figure 8–3 shows Bomb Skid Mk 1 Mod 1, designed for carrying a single 1,000-pound bomb. Figure 8–4 shows the same skid outfitted with the Mk 3 adapter for carrying eight aircraft rockets.

Bomb and torpedo skids may be divided into two groups, those with wheels and those without wheels. Skids with wheels are rolled directly under the airplane, at which point

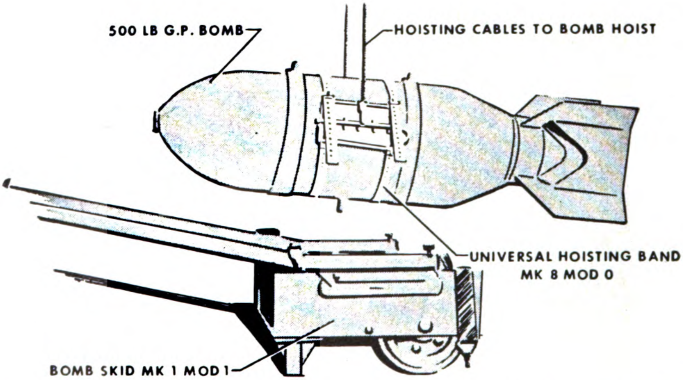


Figure 8–5.—Bomb Skid Mk 1 Mod 1 and associated hoisting equipment.

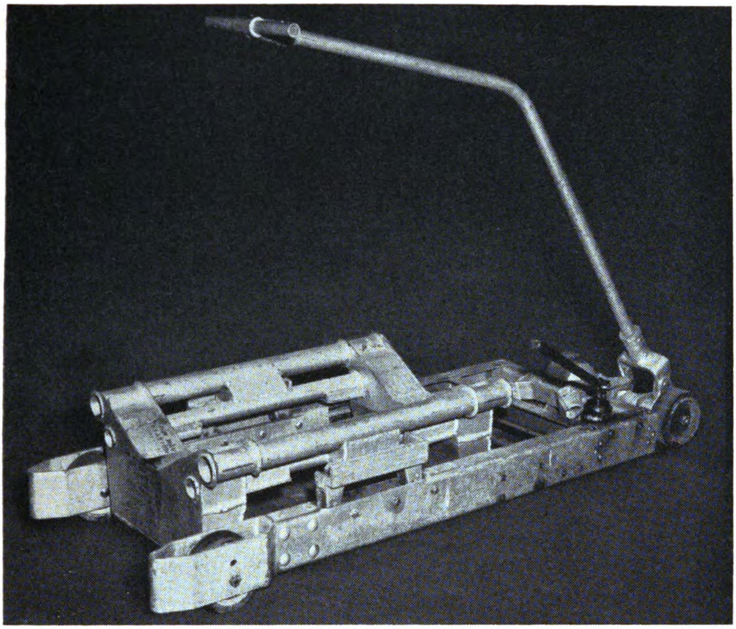


Figure 8–6.—Bomb and Torpedo Skid Mk 3 carried by Bomb and Torpedo Truck Mk 3.

heavy loads (bombs and torpedoes) are usually hoisted to the bomb racks or shackles by means of a portable bomb hoist, as shown in figure 8–5. Skids without wheels are used in conjunction with a bomb and torpedo truck as shown in figure 8–6.

Bomb Skid Mk 1 Mod 1

The Bomb Skid Mk 1 Mod 1 is a wheelbarrow-type skid for use aboard ship and at shore stations. It consists of a welded steel frame with two rubber-capped wheels and two legs aft of the center of gravity. The wheels may be removed and replaced by a track-laying attachment consisting of two Mk 1 track-laying wheels, an axle, and two brackets for mounting the attachment to the skid. This attachment is designed to allow a loaded skid to be moved over mud, sand, or soft or rough ground, where wheeled equipment cannot be operated effectively. The Mk 1 Mod 2 skid comes equipped with the track-laying attachment (see fig. 8–7).

A single 1,000-pound bomb should be loaded with the nose of the bomb aft to permit easier handling of the skid. The bomb should be clamped tightly to the skid by means of the hold-down strap.

The wheels are braked by means of two brake shoes which are applied to the wheels when the aft end of the skid makes contact with the deck.

Maintenance.—Lubricate the wheel bearings when necessary with a medium-weight bearing grease. Alemite fittings are provided on each wheel for this purpose, and require the use of a regular alemite grease gun.

If the brakes do not set properly, tighten the adjusting bolts until the brakes will set when the skid is resting on the deck.

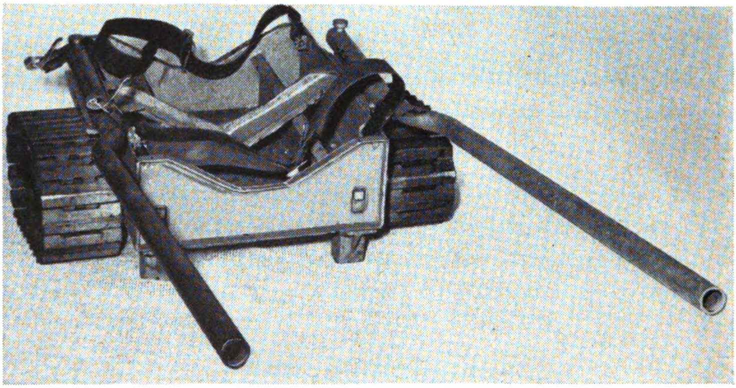


Figure 8–7.—Bomb Skid Mk 1 Mod 2.

Adapters for Bomb Skid Mk 1.—The following adapters may be fitted to the Mk 1 skid for transporting various types of loads as shown:

Adapter Mk 1—Three 100-pound bombs.

Adapter Mk 2—Eight 3.5-inch diameter rockets.

Adapter Mk 3—Eight 5.0-inch diameter rockets.

Adapter Mk 4—Six 100-pound bombs or 16 ammunition cans.

Bomb and Torpedo Skid Mk 3

The Mk 3 skid is a simple welded steel stand for supporting bombs or torpedoes during handling operations. The skid may be carried and lifted by means of a bomb and torpedo truck. Capacity of the skid is 2,000 pounds.

When lifting the loaded skid with a bomb and torpedo truck, and additional height is needed, stack one skid on top of another, with the tubular sides of the two skids parallel. Lash the torpedo or bomb and the two skids together to insure stability.

The Mk 3 skid is commonly used in torpedo workshops as it forms an excellent torpedo stand upon which a torpedo may be held in a ready condition, or upon which a torpedo may be kept while being repaired.

Bomb and Torpedo Skid Mk 5 Mod 1

The Bomb and Torpedo Skid Mk 5 Mod 1 is a four-wheel, cradle-type skid capable of supporting any bomb or torpedo in common use up to a maximum weight of 2,500 pounds and a maximum diameter of 24 inches. The skid is maneuvered by means of a loop-type tow handle at the forward end of the skid.

The two front wheels may be locked, to prevent free swiveling, by means of the caster lock. To free the caster wheels, permitting the skid to be turned, the caster locks should be raised. When the resting shoes of the extension leg are resting on the deck, the rear wheels are braked. Lifting the extension legs approximately 2 inches raises the brake shoes from the rear wheels, thus permitting the skid to be moved.

When the loaded skid is placed on a ship's elevator or in any other position where an extended tow handle would be an obstruction, the tow handle may be swung up to a vertical position by releasing the handle latches. The extension legs remain resting on the deck, leaving the skid in a braked condition.

Maintenance of the Mk 5 Mod 1 is the same as for the Mk 1 Mod 1.

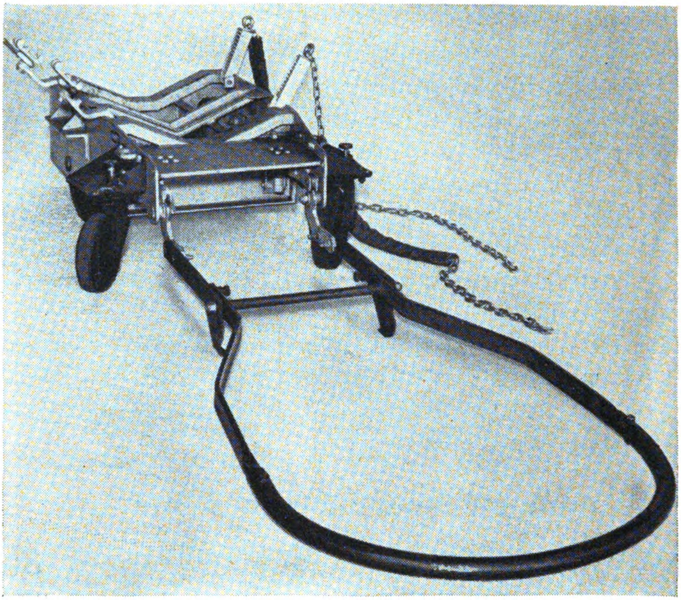


Figure 8–8.—Bomb and Torpedo Skid Mk 5 Mod 1.

Bomb Skid Mk 8

The Mk 8 is a wheelbarrow-type skid designed for handling loads up to 2,500 pounds on hard surfaces. The major components of the skid are the frame, wheels, brake mechanism, chain hold-downs, and handles.

The two demountable handles may be attached to either end of the skid. This permits the loaded skid to be maneuvered onto an elevator from one direction and off the same elevator from the opposite direction. When the handles are inserted, they latch automatically in place. The handles are removed by releasing the latches which are located at the operator's end of the handles.

The automatic brakes are identical to those on the Mk 1 skid, but a cam-locking parking brake is also provided. This is a safety brake designed to keep a parked skid from getting away in rough weather or when the aircraft carrier is maneuvering.

MAINTENANCE.—There are four alemite grease fittings on the skid, one on each wheel hub, and one on each of the floor brake arm bearings.

The clearance between the brake shoes and their respective wheels should be kept at approximately 1/32 inch for maximum efficiency. To adjust the brakes proceed as follows: Suspend the aft end of the skid so that the floor brake legs are free from the deck. Loosen the floor brake adjusting nuts and the parking brake adjusting nut. Adjust each floor brake rod so that the clearance between the brake shoe and wheel is 1/32 inch. Tighten the floor brake adjusting nuts, then adjust the parking brake rod so that the parking brake rod spring has no slack remaining. Tighten the parking brake adjusting nut.

Bomb Skid Aero 12B

A new series of handling equipment is the Aero 12B Bomb Skid and associated adapters, Aero 8B and Aero 9B.

Outstanding improvements include bigger wheels, new rubber compound for the tires, new tire tread, lighter weight, and a reduction in storage space required.

The new tire tread is nondirectional. Regardless of the angle at which the bomb skid wheels hit an arresting gear cable, or similar deck obstacle, they ride over with ease.

All operating parts of the bomb skid such as wheels, brake mechanism, handles, chocks, and hold-downs are completely interchangeable. Handles may be latched on to either end of the skid, the latch control being located at the operator's end of the handles. Thus the operator, after loading the skid on the ship's elevator, does not have to enter the elevator to unlatch and release the handles. The skid is capable of transporting any store up to 1,000 pounds, from the ammunition room, up through any combination of upper and lower stage elevators, on any aircraft carrier. It is 33 pounds lighter in weight than the Mk 1 skid.

A description of the associated adapters for the Aero 12B follows.

AERO 8B BOMB SKID ADAPTER.—The adapter is a frame upon which are mounted adjustable supporting stumps designed to handle six of any type rocket from 2.75 to 5 inches in diameter. No loose or interchangeable parts are required to accommodate the various diameter rockets.

Aero 9B Bomb Skid Adapter.—This adapter is a collapsible box, the sides and ends of which are attached to the base of the adapter with piano type hinges. When assembled and ready for transporting stores and miscellaneous equipment, the sides and ends of the adapter are held in position with four simple bolts. The adapter is capable of transporting practice rockets, rocket heads, rocket motors, belted ammunition, ammunition cans, and any packaged pyrotechnics up to its 1,000-pound capacity. In its collapsed position, the adapter can be hung on a bulkhead or stacked on the deck.

PORTABLE BOMB HOISTS

Bomb Hoist Mk 8

The Portable Bomb Hoist Mk 8 is a crank-operated, single cable device for manually hoisting a bomb or torpedo into position for attaching to a bomb rack or shackle. The hoist weighs approximately 50 pounds and is capable of lifting 2,240 pounds to a height of 120 inches. Heavier loads may be lifted by using two hoists.

The hoist consists of four main subassemblies: (1) the brake and crank group, by means of which power is applied and the load prevented from lowering itself; (2) the gear train group, by means of which the force applied to the crank is multiplied, enabling one man to lift the heavy load; (3) the drum and cable group; and (4) the extension tube group, by means of which the load may be raised to a height above that of the operator.

The brake and crank group, gear train group, and drum and cable group are assembled in a housing which has a spade grip handle for supporting and steadying the hoist. A woven strap having a snaphook at each end is also provided. This strap may be used instead of the spade grip handle for supporting the hoist in use, thus freeing both hands for turning the cranks. When very heavy bombs are being loaded the operator may hold the hoist down by putting his foot in the loop in the strap.

One end of the extension tube fits into a slotted cylindrical opening in the housing while the outer end of the tube carries the pulley, pulley trunnions, and swivel clevis.

The extension tube is held tightly in place within the housing by the clamp screw (see fig. 8–9). By loosening the clamp screw, the extension tube may be rotated 90° in either direction from normal mid-position. This allows a more flexible use of the hoist in the restricted working space that is encountered in loading some airplanes.

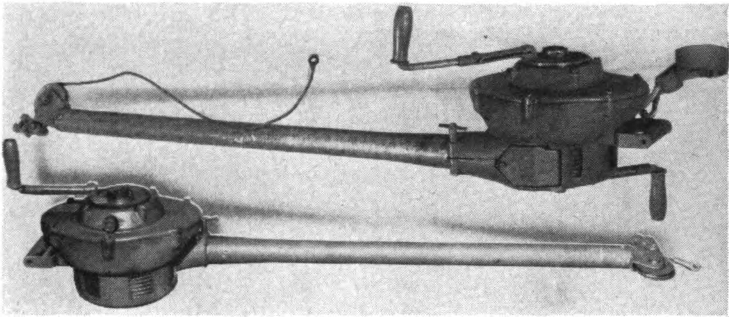


Figure 8–9.—Portable Bomb Hoist Mk 8.

The pulley trunnions and swivel clevis provide means of attaching the hoist to the airplane. The pulley trunnions engage a hoist fitting which is provided on the sides of certain bomb racks, such as the Mk 51 type. When the swivel clevis is used it is bolted to an attachment on the airplane structure. The swivel clevis permits the hoist to be swung into almost any position for ease of cranking..

Operation of Bomb Hoist Mk 8

Hoisting a load.—To hoist a load turn either right-hand or left-hand crank clockwise. For heavy loads use both cranks. If cranking must be interrupted before the bomb has

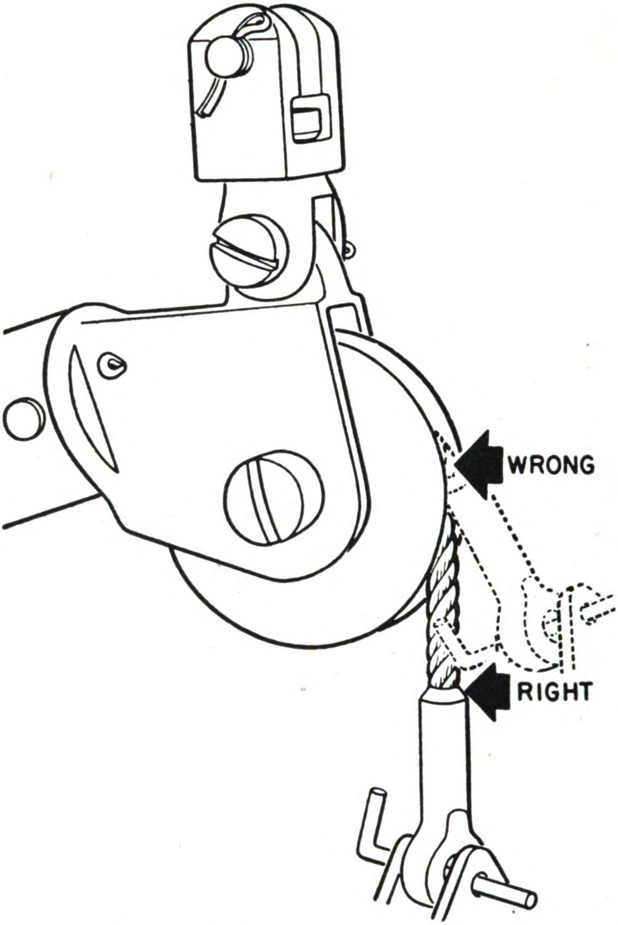


Figure 8–10.—Minimum safe distance between cable terminal and pulley.

been secured in place, the brake will hold it suspended until cranking is resumed.

Lowering a load.—Set the release lever on the left-hand crank in neutral or released position and turn the right-hand crank counterclockwise. The turning of the crank releases the brake, permitting the load to descend of its own weight. Should the speed become too great, it can be slowed or stopped by slowing down or stopping the crank.

Safety precautions.—When approaching the "two-blocked" position (all the way up), take care that the cable terminal does not ride up onto the pulley (see fig. 8–10). If this happens the cable terminal will damage the cable at the point where it enters the terminal, thus causing cable failure.

Never cock the pulley at such an angle that the hoist cable is caught between the pulley guide and pulley (see fig. 8–11). If this is done the pulley housing, cable, and pulley will all be damaged and the cable may be broken.

When a bomb is "two-blocked" into position never crank even a small part of an extra turn. If this is done the stress on the cable assembly is greatly increased, causing weakening or breakage.

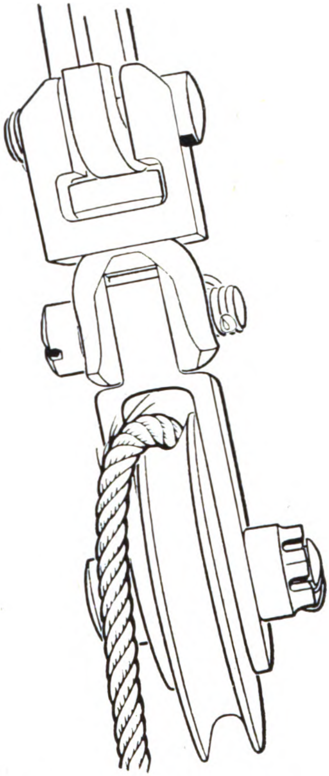


Figure 8–11.—Cocked pulley.

Never stand (or allow others to stand) under a load while hoisting or lowering.

Maintain tension on the cable at all times when paying out or reeling in with no load attached. (This is especially important since the cable may kink or ride off the drum.)

Always put the left-hand crank in neutral when lowering a load. If this is not done the left-hand crank will windmill.

Watch the cable at all times to see that it is seating properly on the drum and that there is no slack cable behind the pressure roller.

Bomb Hoist Aero 13B

The Bomb Hoist Aero 13B is a crank-operated, single-cable hoisting device resembling the Mk 8 in appearance, operation, and function. The principal new features are: (1) a safety overload device, and (2) a quick-reel in and free-reel out mechanism.

On each crank a safety overload device is provided which is set at the factory to slip at a 3,000-pound load. The crank handles are equipped with a spring-loaded slipping cam pin, and are so arranged that the manual effort will pass directly through these pins to the hoist drum. When attempting to lift a load in excess of 3,000 pounds with one crank, the pin will be dislodged from its provided recess, the handle will slip, and the crank will rotate until the pin is allowed to reenter its original position. This slipping is an indication that the hoist is being subjected to a load in excess of its capacity.

In the hub of the left-hand crank is a drum pin. This pin is used ONLY when you wish to quick-reel in cable under no load. Engaging this pin places the left-hand crank in a one to one ratio with the drum. To quick-reel in cable with no load, pull the free-reel handle to the complete OUT position. Place the left-hand crank ratchet lever in neutral. Turn and push the drum pin to full engagement. Rotate the left-hand crank counterclockwise to reel in cable.

To free-reel out cable pull the free-reel handle to the complete OUT position. Pull the drum pin out and turn. Cable is then payed out by applying tension (do not jerk) to the free end of the cable.

Caution: Free-reeling must be used only under no load.

Other than the above described features, the Aero 13B hoist is identical to the Mk 8 in operation and function.

Electric Bomb Hoist Aero 11A

The Bomb Hoist Aero 11A is supplied as a twin unit, primarily used for bomb loads, and as a single unit for other loads. Each model can be operated either manually or electrically. In the twin unit either motor or both motors can be operated for hoisting or lowering, but the two motors cannot be operated in opposite directions at the same time. The maximum lift for a twin unit is 2,240 pounds and for a single unit 1,120 pounds.

The complete hoist assembly consists of four subassemblies, designated as power unit, hoist mechanism, base plate, and handcrank.

The power unit is made up of the electric motor and housing, motor planetary gear train and housing, solenoid and solenoid housing, remote control hand unit and power cable. The electric motor manufactured by Lamb Electric Company, is a 24-volt, direct-current, two-pole, compound-wound reversible motor, rated one horsepower at 7,000 r. p. m.

The hoist mechanism subassembly is made up of the drum assembly, cable roller assembly, hoist housing cover assembly, hoist housing assembly, brake mechanism, drive shaft, and a housing.

The base plate is a heavy aluminum alloy plate, properly drilled to locate the hoist units.

The handcrank is used where there is no power supply available, or in the case of power failure. The hub of the handcrank is splined to fit on the end of the drive shaft.

OPERATING INSTRUCTIONS.—Connect the power cable to the power supply and solenoid power line connections. Connect the control cable so that the white button controls the hoist with the white safety hook; and the black button controls the hoist with the black safety hook.

HOISTING.—Placing the toggle switch in the hand control unit in the UP position is the initial step.

Depressing either pushbutton switch in the hand control permits current to flow into the hand control switch, thus energizing the solenoid coil.

Energizing the solenoid coil causes the plunger to close the solenoid switch contacts, and energize the motor to produce hoist action.

LOWERING.—Placing the toggle switch in the hand control unit in the DOWN position is the first step.

Depressing either pushbutton switch produces an action similar to that described above, except that the opposite coil in the solenoid is energized, closing the other set of switch contacts, which reverses the polarity of the motor and produces the lowering action.

MANUAL OPERATION.—For manual operation of the hoist, remove the motor unit and install the handcrank.

HOISTING BANDS AND SLINGS

Hoisting bands and slings are used for lifting bombs and torpedoes in conjunction with other hoisting equipment. Each band or sling is specially designed for lifting certain sizes and types of bombs or torpedoes into position for attachment to the bomb racks or shackles.

The terms "band" and "sling" are sometimes used interchangeably, but as a general rule, items made of stranded cable are designated as slings while those made of solid metal bands are designated as bands.

The most commonly used bands and slings are described in this section.

Torpedo Hoisting Band Mk 1 Mod 2

The Torpedo Hoisting Band Mk 1 is a double-sectioned circular steel strap used in hoisting aircraft torpedoes. The sections are fastened together by a takeup bolt and nut at one end and by two clip rivets and locking slots at the other end. Two clevises with hoisting brackets are provided.

The band is placed around the torpedo with the hoisting

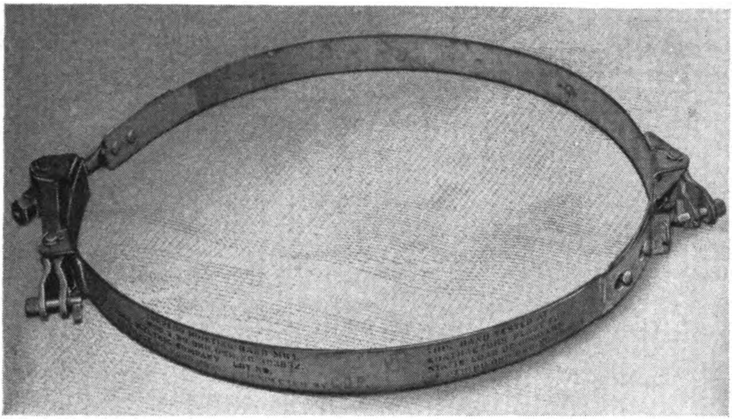


Figure 8–12.—Torpedo Hoisting Band Mk 1.

brackets on each side. After the takeup nut is tightened, the torpedo is hoisted into position by two bomb hoists. The band is removed by unscrewing the takeup nut and separating the band at the locking slots. Capacity of the band is one 2,200-pound torpedo.

Universal Hoisting Band Mk 8

The Universal Hoisting Band Mk 8 is an adjustable assembly of steel straps and connecting plates used to hoist bombs and torpedoes.

Each Mk 8 outfit consists of one hoisting plate with takeup mechanism; one takeup plate; two hoisting-plate assemblies; and four 6-foot lengths and four 2-foot lengths of perforated steel straps (32 feet). The assembly is converted into a double-band assembly by combining takeup and hoisting plates with the proper straps and connector fittings. The double-band assembly is used to hoist bombs, torpedoes, and mines ranging in diameter from 8 to 48 inches.

One Mk 8 assembly should normally be kept ready for use with each diameter of bomb regularly handled. It need not be completely disassembled when removed from the bomb.

The Mk 8 provides two basic methods of hoisting: (1) by single or double cable for suspension from a bomb rack;

and (2) by single or double cable for suspension from a bomb shackle. The capacity for double-cable hoisting is 4,000 pounds. Figure 8–5 shows the Mk 8 being used in double-cable hoisting of a 500-pound GP bomb.

Hoisting Sling Mk 19

The Mk 19 is used for single-cable hoisting of the 500-pound GP Bombs AN–M64, AN–M64A1, and other bombs of comparable size. It is installed by passing the removable end of the cable around the bomb and securing it to the sling-plate fitting with the snap-on clevis pin. If the sling is slack on the bomb, the adjustment nut may be used to take up the slack. No more than finger tightness is required.

Hoisting Sling Mk 21 Mod 0

The Mk 21 sling is used for single-cable hoisting (either bomb rack or shackle suspension) of all bombs having diameter variations from 11.8 inches to 18.8 inches. The adjustment of the sling to suit the diameter of the bomb is accomplished by selecting the proper combinations of ball fittings to give the approximate required diameter and then clamping the sling firmly around the bomb by means of the takeup bolt and nut. When hoisting to bomb racks, the takeup nut must be tightened very snugly.

Hoisting Sling Aero 35A

The Aero 35A sling is used for single or double-cable hoisting of bombs up to 2,500 pounds. The sling consists of two chains and a hoisting plate. The chains are placed around the bomb and attached to the hoisting plate. This sling may be adjusted to a maximum diameter of 24 inches.

Hoisting Sling Mk 22

The Mk 22 sling is used for double-cable hoisting of all bombs having diameters between 10.8 inches and 18.8 inches. The sling is installed and removed in the same manner as the Sling Mk 16. The diameter of the sling is adjusted by placing the appropriate swaged ball fitting into the connecting link.

BOMB AND TORPEDO TRUCKS

All the bomb and torpedo trucks except the Mk 5 have been designed to transport and lift certain loaded skids. Those trucks designed to carry loaded skids may be divided into two groups, namely "high-lift" and "low-lift" type. A "low-lift" truck provides a method of transporting a loaded skid; whereas, the "high-lift" truck, in addition to being used to transport a loaded skid, may be used to lift the loaded skid to the bomb rack or shackle. The Mk 5 (discussed later) is designed for transporting and lifting a single torpedo without the use of a skid (fig. 8–13).

Bomb and Torpedo Truck Mk 2 Mod 2

The Mk 2 Mod 2 truck is a four-wheel, "high-lift" type, designed to lift and transport the Mks 1, 3, and 5 bomb and torpedo skids with their bomb or torpedo loads. It has a weight-carrying capacity of 2,500 pounds.

A handle-operated hydraulic pump controls the truck's lifting mechanism. The lift brackets may be raised 48 inches. They may be tilted forward or aft by means of the handwheel located on the left side of the truck. The tilting mechanism helps to line up the bomb or torpedo with the bomb rack when loading with a skid.

Poor operation of the hydraulic lift system may be due to loose or worn packing. To remedy such a malfunction, tighten the packing nut on the forward end of the lift cylinder and the three screws holding the packing gland on the pump plunger. Remove the plug on the pump box, fill with medium weight oil, and return the plug.

There are eight alemite-type fittings provided on the truck for lubrication. When necessary, lubricate these fittings by means of a grease gun and a medium-weight grease.

Bomb and Torpedo Truck Mk 3

The Bomb and Torpedo Truck Mk 3 is a "low-lift" type truck having a load capacity of 2,500 pounds. A handle-operated hydraulic pump operates the lifting mechanism which raises the lift brackets and a typical load, such as the

Mk 3 Bomb Skid and a bomb or torpedo, about 2 inches. The truck is steered and pulled by means of a steering handle with a crossbar. It is braked by means of a brake handle at the crossbar of the steering handle. Maintenance of the Mk 3 truck is similar to that described for the Mk 2.

Bomb and Torpedo Truck Mk 5 Mod 2

One of the best torpedo handlers for shipboard work is the Bomb and Torpedo Truck Mk 5 Mod 2, as illustrated in figure 8–13. It is a cradle-bed type of 2,500 pound capacity, primarily designed to support and carry a torpedo of the Mk 13 type. To aid in attaching the torpedo to the airplane, it is provided with 2 hydraulic jacks which are used to raise the front end of the truck.

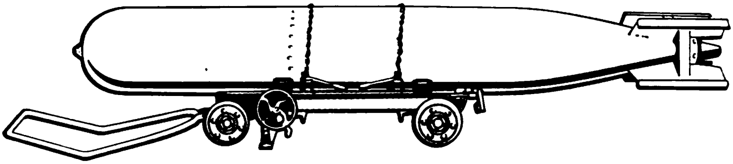


Figure 8–13.—Bomb and Torpedo Truck Mk 5.

The truck is moved and steered by a loop handle or drawbar attached to the center-pivoted front axle. Chain holddowns are provided to retain the torpedo in place. Foot-operated brakes are provided. Maintenance of the Mk 5 Mod 2 is similar to that for the Mk 2.

BOMB TRAILERS

At shore bases where the terrain is not too muddy or sandy, bomb trailers may be used in place of skids or trucks to transport bombs or torpedoes. Trailers are usually towed in train by means of a bomb service truck or tractor. In some cases the trailer may be rolled right under the airplane, from which point the bombs are hoisted to bomb racks or shackles. In cases where the airplane is too low, the bomb or torpedo must be switched to a skid and/or truck and thus rolled under the airplane.

Bomb Trailer Mk 2 and Mods

The Mk 2 is a low-slung, heavy type trailer with a central cradle for bombs up to and including the 2,000-pound type. Bombs are held in the cradle by a load-binder chain and eccentric tightener. The Mk 2 has small wheels and is used to position bombs under airplanes when there is little space between the fuselage and the ground.

Bomb Trailer Mk 3

The Mk 3 bomb trailer is a four-wheel, pneumatic-tired trailer with pivot-type ammunition cradles. The trailer may carry any one of the following loads:

Four 500-pound bombs.
Four 1,000-pound bombs.
Two 2,000-pound bombs.
One 4,000-pound bomb.
One aircraft torpedo.

The trailer has a fold-back drawbar with a coupling eye. A pintle hook is mounted on the rear frame. As many as four of these trailers may be moved in train by the Mk 2 bomb service truck.

The eight inboard, load-carrying cradles pivot outward to form a single cradle in the center for a torpedo or a 4,000-pound bomb. They pivot inward to form, with the outer brackets, two parallel cradles for two to four bombs.

Bombs or torpedoes are held in place by an adjustable load binder and chain assembly tightened by a lever. Four load binders may be installed on a trailer. Binders that are not in use are carried in the tool box.

Caution: Never permit the chains on these trailers to be slack. A loose chain may strike the ground and cause sparks.

The tool and fuze box mounted on the underside of the frame contains all required maintenance tools. A battery box mounted forward within the frame carries a battery for emergency operation of the Warner electric brakes on the rear wheels of the trailer. A hand lever operates the parking brakes.

Other equipment includes a blackout tail and stop light, a blackout switch, an electric lantern, and a push-pull switch to cut out the individual tail and stop light when the trailer is not at the end of the train.

MISCELLANEOUS HANDLING EQUIPMENT

Cranes and Fork Trucks

After bombs have been delivered to a magazine, one of the best devices for use in stowing them is the electric magazine crane truck, TLN–2, shown in figure 8–14. This is an industrial truck equipped with a 60-inch boom capable of swinging through a 60° arc on each side of the centerline of the truck. The boom has a 1-ton lifting capacity and has an overall lifting height of 117 inches from hook to deck. It is powered by a 16-cell, 450-ampere-hour, lead-acid battery. The truck is used for handling bombs in high-explosive magazines and railroad boxcars.

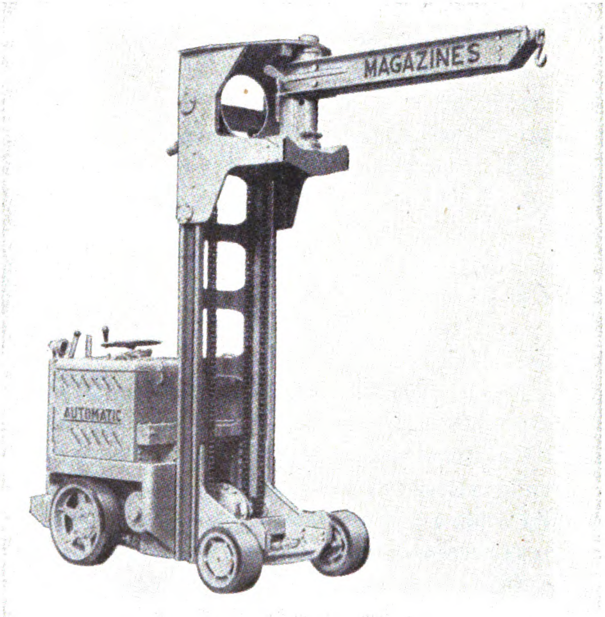


Figure 8–14.—Electric magazine crane truck.

The electric magazine crane truck is transported from the battery-charging house to the magazines in a low-bed machinery trailer. Batteries may be changed in the field by use of the movable chain fall on the Mk 2 bomb service truck. The bomb-lifting hooks then serve to lift the battery.

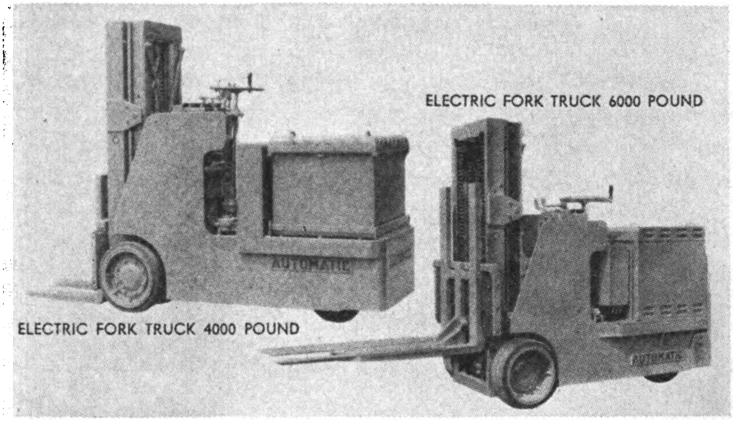

ELECTRIC FORK TRUCK 6000 POUND
ELECTRIC FORK TRUCK 4000 POUND

Figure 8–15.—Electric telescopic fork truck.

Another vehicle used in the handling of bombs is the fork truck shown in figure 8–15. This two-ton electric fork truck, when equipped with a non-slewing, telescopic boom attachment (in lieu of the forks), may be used for handling bombs up to one ton capacity. The overall lifting height of the truck is 120 inches. It is of spark-enclosed construction and is equipped with a 16-cell, 450-ampere-hour, lead-acid battery. This truck when equipped with forks is capable of handling pallets up to a maximum of 48 inches square.

Bomb Service Truck Mk 2

The Bomb Service Truck Mk 2, a 1½-ton 4 x 4 Ford truck, is used to load or tow bomb trailers. For towing, a pintle hook (Type T–100) is attached to the rear cross-member of the truck. Warner electric brake control equipment on the truck gives the operator control of the brakes on the towed bomb trailers.

For loading, the truck has a movable chain hoist, a fixed overhead winch, and a monorail beam. The chain hoist is manually operated and has a capacity of 1½ tons. The winch, mounted on top of the forward end of the beam, has a capacity of 4,000 pounds.

Bomb Service Truck Mk 2 Mod 1

The Mk 2 Mod 1 is similar to the Mk 1 except that it is equipped with dual rear wheels and a power-driven, front-mounted winch. The winch is used for pulling, and has a load capacity of 10,000 pounds. The winch driveshaft has a SPECIAL SHEAR PIN to protect the truck chassis frame and the wire rope. NEVER SUBSTITUTE SHEAR PINS WITH RIVETS, BOLTS OR PINS which may not shear in time to prevent injury to personnel or damage to the vehicle.

Floodlight Trailer

The "SPEN" portable lighting unit (shown in fig. 8–16) is used to provide proper lighting during night operations. It is a spring-mounted, 2-wheel trailer. The drawbar has a retractable drop-leg with a pneumatic-tired wheel to maintain the unit in a level position and provide mobility when the trailer is removed from the towing vehicle. A handbrake holds the trailer in position when it is not attached to a tow vehicle.

The trailer carries a 4-cycle, 7.8 horsepower, air-cooled gasoline engine directly coupled to a 3-kilowatt, 110-volt, 60-cycle, 27.5-ampere generator, a control panel, 5 floodlights, 3 reels (each having 100 feet of cable), 3 tripods and 2 telescoping standards. The 3 floodlights mounted toward the rear of the trailer are removable and can be mounted on tripods, provided for that purpose, at any distance up to 100 feet from the trailer. The 2 remaining floodlights can be raised to any desired height up to 8 feet. The lights can be rotated 360°, and locked in any position. Each floodlight contains a 250-watt lamp.

The following safety precautions should be observed when operating the unit:

Never operate the unit in a closed space unless provisions have been made to discharge the exhaust gases outside.

Never operate the unit in a magazine.

Never operate the unit within 50 feet of an aircraft or a LOADED magazine.

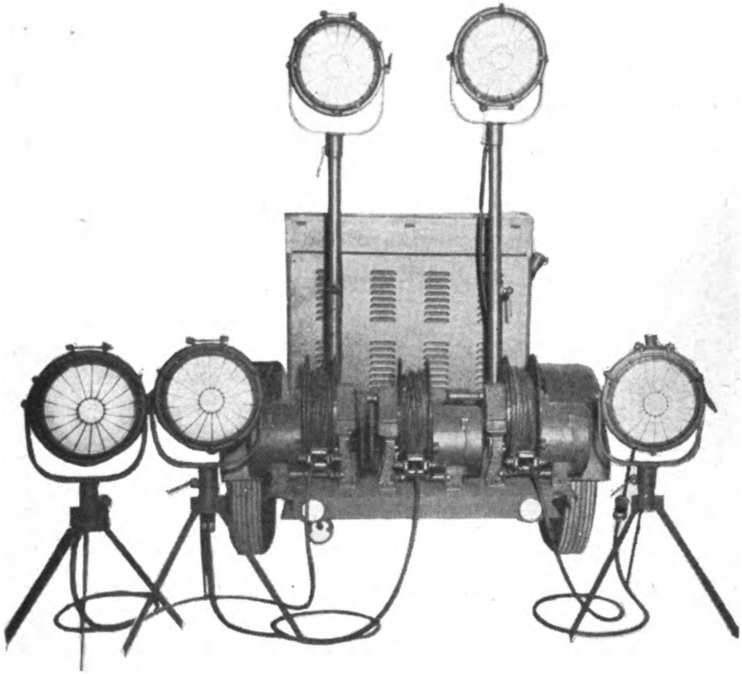


Figure 8–16.—SPEN portable lighting unit.

Before starting the unit, check carefully to see that it is clean, that there are no oil or gasoline leaks, that oil is at proper level, that there are no loose parts and that no tools or other objects are on the unit which might interfere with its operation.

QUIZ

1. Some bomb carriers are designed for _________ lifting, while others are for __________ lifting.
2. Bomb skids may be divided into __________ groups.
3. Bomb skids without wheels are usually used in conjunction with __________.
4. What is the purpose of bomb skid adapters?
5. What are the two most important improvements in the Mk 8 bomb skid over the Mk 1 and Mk 5?
6. What two methods are used for lifting bombs and torpedoes to the bomb racks or shackles?
7. What is meant by the term "two-blocked" in hoisting?
8. What precaution should be taken when approaching the "two-blocked" position?
9. The Mk 8 bomb hoist is attached to the airplane by either the __________ or the __________.
10. What advantage has the Mk 3 bomb trailer over skids and trucks for transporting bombs and torpedoes?

APPENDIX I

ANSWERS TO QUIZZES

CHAPTER 1

INTRODUCTION TO AVIATION ORDNANCE

1. Ordnance and armament equipment.
2. Carrier air group.
3. A group of patrol squadrons under one tactical commander.
4. Administration, Operations, Maintenance, Material, and Gunnery (or Ordnance).
5. Fleet aircraft service squadron.
6. Carrier and patrol.
7. Operations.
8. Air.
9. Ordnance and Aeronautics.
10. Index of Ordnance Publications.
11. Naval Aeronautic Publications Index.
12. BuOrd Section.
13. Stub Requisition.
14. Ammunition Stock Recording System.

CHAPTER 2

EXPLOSIVES

1. Chemical change (or rate of detonation).
2. Propellant or low explosive.
3. Black powder.
4. "An ether alcohol colloid of nitrocellulose."
5. Fulminate of mercury and lead azide.
6. High-order.
7. Toluol (or toluene).
8. Soap or other alkaline substances.
9. Explosive D (or ammonium picrate).
10. Booster.
11. HBX–1.

CHAPTER 3

BOMBS AND MINES

1. General purpose (GP), armor-piercing (AP), semi-armor piercing (SAP), depth, and fragmentation.
2. Weight of explosive to total weight of the bomb.

3. 50.
4. 30 inches.
5. Tail only.
6. Olive drab.
7. To reduce ricochetting.
8. Parachutes.
9. Gas, smoke, or incendiary.
10. Drifting, moored, and ground.
11. Ground.
12. Parachutes.
13. Hydrostatic pressure (water pressure).
14. Magnetic, acoustic, and pressure.
15. Moisture.

CHAPTER 4

BOMB FUZES

1. Arming vane and arming pin.
2. Arming wire.
3. 0.1.
4. Water-discriminating.
5. 5 to 92.
6. Ring and bar.
7. Non-delay, 0.01, 0.025, 0.1, and 0.24.
8. M115.
9. One to 144 hours.
10. False. First, the aircraft should never return the bombs to the ship. Second, if they were returned, NO ATTEMPT MUST BE MADE TO REMOVE THE FUZES. The bombs should be lowered over the side and dropped into deep water, or otherwise disposed of.
11. Armor-piercing.
12. Air travel and hydrostatic (or water) pressure.
13. Napalm (or fire).
14. False. No attempt shall be made to disassemble fuzes, except in those special cases noted in the Safety Precautions section. Army-designed fuzes shall NEVER be disassembled for any reason.

CHAPTER 5

AMMUNITION

1. Bullet, propelling charge, primer, and cartridge case.
2. A bullet with a tapered base is said to be boattailed.
3. To ignite the propelling charge.
4. (1) Caliber; (2) Gage.
5. Color.

6. To designate in what type weapon or weapons the lot may be fired.
7. Unserviceable.
8. Armor-piercing-incendiary.
9. Projectile, fuze, propelling charge, primer, and cartridge case.
10. Small-arms ammunition includes only .60 caliber and smaller.
11. (1) Keeps the projectile seated firmly in the gun bore.
    (2) Acts as a gas seal.
    (3) Causes the projectile to spin when fired.
12. Percussion and electric.
13. It contains no interrupter or other safety device.
14. A fulminate of mercury detonator, a relay charge of lead azide, and a booster charge.
15. Kind and type of projectile, caliber, and model designation.

CHAPTER 6

ROCKETS AND JATO

1. Head.
2. Black powder.
3. 100.
4. False. Base fuzes should NEVER be removed.
5. Mk 149 Mod 0.
6. Gas pressure, inertia, and deceleration.
7. Subcaliber Aircraft Rocket.
8. 715.
9. (1) Ballistite.
   (2) 1,360.
10. (1) Composition B.
    (2) Munroe.
11. Magneto.
12. Air.
13. (1) Gray.
    (2) White.
14. (1) Continuity.
    (2) No-voltage.
15. None.
16. Vertical with nozzle end up.
17. A full-voltage or continuity test and a no-voltage test.

CHAPTER 7

PYROTECHNICS AND SMOKE SCREEN EQUIPMENT

1. Marking.
   Signaling.
   Illumination.

2. 1,000,000.
3. Night antisubmarine.
4. Night photography.
5. Pyrotechnic Pistol AN–M8.
6. (1) Smoke.
   (2) Light (or star).
7. Fluorescein.
8. 30 seconds.
9. False.
10. Aircraft Chemical Tank Mk 10.
    Airplane Smoke Tank AN–M33A1.
11. Mk 1 Mod 7.
12. FS (sulfur trioxide in chlorsulfonic acid).
    FM (titanium tetrachloride).

CHAPTER 8

MUNITIONS HANDLING EQUIPMENT

1. Vertical and horizontal lifting.
2. Two.
3. Bomb and torpedo trucks.
4. Allows a skid to be used for various types and sizes of loads.
5. (1) Handles attachable at either end of the skid. (2) Parking brakes.
6. (1) Portable bomb hoists. (2) "High-lift" trucks.
7. All the way up.
8. Take care that the cable terminal does not ride up onto the pulley.
9. Pulley trunnions or the swivel clevis.
10. Carries a much larger load.

APPENDIX II

QUALIFICATIONS FOR ADVANCEMENT IN RATING

AVIATION ORDNANCEMEN (AO)

RATING CODE NO. 6500

General Service Rating

Scope

Aviation ordnancemen maintain, service, remove, repair, install, operate, and handle small arms and aviation ordnance equipment, including aircraft guns, turrets, powered gun mounts, rocket launchers, suspension and release mechanisms, and pyrotechnic, tow-target, and munitions handling equipment; operate and perform routine servicing and checking of aviation gun, bomb, and rocket sights and aviation fire control equipment including that which is electronically controlled; stow, maintain, service, handle, install, and remove aviation munitions and pyrotechnics; maintain and operate a small arms range.

Emergency Service Rating

AVIATION ORDNANCEMEN U (Utility), Rating Code No. 6501 ------	AOU
Maintain, service, remove, repair, install, operate, and handle small arms and aviation ordnance equipment including aircraft guns, rocket launchers, and suspension and release mechanisms, pyrotechnic, tow-target, and munitions handling equipment; operate and perform routine servicing and checking of aviation gun, bomb and rocket sights; stow, maintain, service, handle, install, and remove aviation munitions and pyrotechnics; maintain and operate a small arms range.	
AVIATION ORDNANCEMEN T (Turrets), Rating Code No. 6502 ----	AOT
Maintain, service, remove, repair, install, and operate aircraft turrets and powered gun mounts.	
AVIATION ORDNANCEMEN F (Fire Controlmen), Rating Code No. 6503 --	AOF
Maintain, service, remove, install, and operate aircraft fire control equipment.	

Navy Job Classifications and Codes

For specific Navy job classifications included within this rating and the applicable job codes, see Manual of Enlisted Navy Job Classifications, NavPers 15105 (Revised), Codes AO–6800 to AO–6899.

Qualifications for advancement in rating	Applicable rates			
	AO	AOU	AOT	AOF
100 PRACTICAL FACTORS				
101 OPERATIONAL				
1. Preserve, depreserve, adjust, and install guns	3	3	3	3
2. Operate aviation munitions handling equipment	3	3	3	3
3. Assemble, adjust, and install aviation ordnance fuzes, pyrotechnics, and munitions normally used in own activity	3	3	--	--
4. Stow, handle, and load aviation munitions, pyrotechnics, and aircraft-laid mines, observing local and general safety precautions	3	3	3	3
5. Install, remove, and perform preflight operational checks to gun cameras and their magazines in accordance with local instructions	3	3	3	3
6. Belt and calibrate aircraft gun ammunition	3	3	--	--
7. Install, remove, adjust, and operate tow-target equipment	2	2	--	--
8. Operate electronic fire control equipment to determine proper functioning of ordnance or armament components	2	--	--	3
9. Perform stray-voltage and circuit continuity safety check on aircraft armament circuits in accordance with current instructions	2	2	--	2
102 MAINTENANCE AND/OR REPAIR				
1. Demonstrate safe and proper use and maintenance of measuring instruments and hand and power tools used for aviation ordnance installation, maintenance, and repair	3	3	3	3
2. Use working drawings, blueprints, and wiring diagrams in servicing, repairing, assembling, and installing aviation ordnance equipment	3	3	3	3

	Qualifications for advancement in rating	*Applicable rates*			
		AO	AOU	AOT	AOF
102	MAINTENANCE AND/OR REPAIR				
	3. Select and demonstrate safe and proper use of all instruments furnished as general test equipment in own unit	3	3	3	3
	4. Inspect, clean, lubricate, preserve, adjust, and replace minor parts of aircraft sights	3	3	3	3
	5. Inspect, clean, lubricate, adjust, and preserve aircraft turrets	3	--	3	--
	6. Inspect, clean, service, lubricate, adjust, preserve, depreserve, and perform authorized repairs to small arms, and aircraft guns	3	3	--	--
	7. Inspect, clean, lubricate, preserve, and perform authorized parts replacement, tests, and adjustments to aviation ordnance handling equipment, except automotive equipment	3	3	--	--
	8. Boresight and aline aircraft sights, guns, and gun cameras	2	2	2	2
	9. Check, adjust, and/or aline aircraft bomb and rocket suspension and release equipment	2	2	--	2
	10. Inspect, clean, and lubricate aviation electronic fire control equipment	2	--	--	3
	11. Demonstrate safe and proper use of specialized ordnance test equipment	2	2	2	2
	12. Replace unserviceable parts, assemblies, or subassemblies; aline, test, and make required adjustments to aircraft turrets	1	--	2	--
	13. Adjust, preserve, and make minor parts replacements not requiring realinement to aviation electronic fire control equipment	1	--	--	2
	14. Prepare charts and design templates for use in boresighting aircraft armament	1	1	1	1
	15. Maintain and service aircraft gun ammunition linking and delinking equipment	C	C	--	--

Qualifications for advancement in rating	*Applicable rates*			
	AO	AOU	AOT	AOF
103 ADMINISTRATIVE AND/OR CLERICAL				
1. Maintain required inventory and performance records of aviation armament and ordnance equipment, munitions, and pyrotechnics	3	3	3	3
2. Use applicable publications and instructions for the handling, stowage, issue, maintenance, and operation of aviation ordnance and armament equipment, munitions, and pyrotechnics	3	3	3	3
3. Instruct in safety regulations and precautions pertaining to small arms and aviation ordnance	2	2	2	2
4. Train and supervise personnel engaged in maintenance and repair of:				
a. Aircraft armament and aviation ordnance equipment; excluding fire control equipment	1	1	--	--
b. Aircraft turrets	1	--	1	--
5. Train and supervise personnel in proper handling of aviation munitions and pyrotechnics	1	1	--	--
6. Train and supervise personnel engaged in maintenance of aviation fire control equipment	C	--	--	1
7. Organize and administer facilities for maintenance and repair of aviation ordnance and armament equipment	C	C	C	C
8. Supervise the use, filing, and maintenance of publications, logs, and records and preparation of reports required by own activity	C	C	C	C
9. Determine allowances; requisition, supervise inventory of, and account for allowed materials in accordance with current directives	C	C	C	C
10. Organize, instruct in, and conduct small arms firing practice	C	C	--	--

Qualifications for advancement in rating	*Applicable rates*			
	AO	AOU	AOT	AOF
200 EXAMINATION SUBJECTS				
201 OPERATIONAL				
1. Safety precautions for handling and stowing aviation munitions, pyrotechnics, and aircraft-laid mines	3	3	3	3
2. Safety precautions to be observed in the use of aviation munitions, pyrotechnics, and ordnance equipment	3	3	--	--
3. Types, nomenclature of parts, and assemblies of:				
a. Small arms and aircraft guns	3	3	3	3
b. Aircraft turrets	3	--	3	--
c. Aircraft sights	3	3	3	3
d. Aviation electronic fire control equipment	3	--	--	3
e. Fuzes	3	3	--	--
4. Types, operation, and components of aviation ammunition, bombs, rockets, fuzes, pyrotechnics, and JATO	3	3	--	--
5. Procedures, sources of information, and safety precautions for belting and calibrating aircraft gun ammunition	3	3	--	--
6. Operating principles and functions of those components common to all aircraft equipment in each of the following groups:				
a. Aircraft noncomputing sights	3	3	3	3
b. Aircraft computing sights	2	--	2	3
c. Bomb sights	2	--	--	3
d. Bomb directors	1	--	--	2
7. Operating characteristics of electrical and hydraulic aircraft turrets	2	--	3	--
202 MAINTENANCE AND/OR REPAIR				
1. Proper use of measuring instruments and of hand and power tools common to rating	3	3	3	3
2. Identify standard symbols found in electrical wiring diagrams of aviation ordnance equipment	3	3	3	3
3. Tests requiring use of simple ohmmeter, ammeter, and voltmeter	3	3	3	3
4. Determine values of voltage, current, and resistance in series and parallel resistor combinations	3	3	3	3

Qualifications for advancement in rating	*Applicable rates*			
	AO	AOU	AOT	AOF
202 MAINTENANCE AND/OR REPAIR				
5. Cleaning solutions, lubricants, and preservatives used in maintenance of aviation ordnance and armament equipment	**3**	3	3	3
6. Procedures for determining and correcting malfunctions of aircraft guns	**3**	3	2	2
7. Solve problems in:				
a. Square and cubic areas for storage and pressures	**3**	3	3	3
b. Ratio and proportion for hydraulics, pneumatics, and electricity	**3**	3	3	3
c. Graph reading for ballistics and boresighting	**2**	2	2	2
d. Substitution of known values in formula	**2**	2	2	2
8. Procedures for adjusting and maintaining:				
a. Aircraft noncomputing sights	**3**	3	3	3
b. Aircraft computing sights	**2**	--	--	2
c. Bomb sights	**2**	--	--	2
9. Procedures, sources of information, and safety regulations for boresighting aircraft sights, guns, and gun cameras	**2**	2	2	2
10. Procedures for localizing a defective component part in a circuit by means of measurement of voltage, resistance, and current	**2**	2	2	2
11. Procedures for adjustment and maintenance of aircraft bomb and rocket suspension and release equipment	**2**	2	--	2
12. Procedures for adjustment and maintenance of aircraft turrets and powered gun mounts	**2**	--	3	--
13. Procedures and sources of information relative to the preparation of boresighting charts and templates	**1**	1	1	1
14. Identification of standard electronic parts symbols used in schematic drawings	**1**	--	--	2
15. Procedures for adjusting and maintaining bomb directors	**1**	--	--	2
16. Practical applications of the principles of internal and external ballistics to aviation ordnance	**C**	C	C	C

Qualifications for advancement in rating	*Applicable rates*			
	AO	**AOU**	**AOT**	**AOF**
203 ADMINISTRATIVE AND/OR CLERICAL				
1. Purposes and types of entries made in maintenance and inventory records kept for aviation ordnance and armament equipment, aviation munitions, and pyrotechnics	3	3	3	3
2. Safety regulations and precautions pertaining to small arms and aviation ordnance and armament equipment	2	2	2	2
3. Types of information found in each of the following publications: OP, OD, OCL, OHI, OML, ORDALTS, NavAer Publications Index, Aircraft Armament Changes, and Aircraft Armament Bulletins	2	2	2	2
4. Use of applicable allowance lists, OP's, parts catalogs, and forms in the requisitioning, salvage, and survey of aviation ordnance materials	C	C	C	C
5. Procedures and regulations for conducting small arms firing practice	C	C	--	--

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